Air Force Small Business Innovation Research Program
Submitting Proposals on Air Force Topics

Topics #1-3

Special Assistant
For Program Coordination
ASD/AE
Building 57/Bay 1
Wright-Patterson AFB OH 45433

Topics #4-5

ASD/ENO
Engineering Operations Office
Building 14, Room 208
Wright-Patterson AFB OH 45433

Topic #6

ASD/RWEE
Building 28, Room 015
Wright-Patterson AFB OH 45433

Topics #7-9

ASD/TAA
Building 16, Room 120
Wright-Patterson AFB OH 45433

Topics #10-17

Directorate of Concepts
And Innovation
ASD/XRX
Building 11A, Room 201
Wright-Patterson AFB OH 45433

Topic #18

Deputy for Propulsion
ASD/YZD
Building 46, Column 1D5
Wright-Patterson AFB OH 45433

Topics #19-29

Avionics Program Office
AFWL/GLXPA
Building 22, Room S110
Wright-Patterson AFB OH 45433

Topics #30-40

AFWL/GLXPF
Area “B”, Building 653, Room 149
Wright-Patterson AFB OH 45433

Topics #41-60

AFWL/GLXPM
Area “B”, Building 653, Room 406
Wright-Patterson AFB OH 45433

Topics #61-70

AFWL/GLXPP
Programs Group
Building 18A, Room A-103
Wright-Patterson AFB OH 45433

Please note that, because of unique circumstances, proposal deliveries to the Wright-Patterson AFB complex will require additional time (about one day) for processing to the correct office. Accordingly, bidders should plan an additional time allowance for proposal delivery to the correct office as stated in this solicitation. Many FY84 proposals were not considered for evaluation/award because of late delivery.

Topic #71

AFSTC West Coast Office OL-AB
PO Box 92960
Building A2, Room 2205 (S. Wagner)
Worldway Postal Center
Los Angeles, CA 90009

Topics #72-73

HQ Aerospace Medical Divison
AMD/RDO
Directorate of Resources & Operations
Building 150, Room 224
Brooks AFB TX 78235

Topics #74-128

USAF Ballistic Missile Office (BMO)/PMX
Building 951, Room 108
Norton AFB CA 92409

Topics #129-140

WCO/AFSTC
PO Box 92960, WPC
Los Angeles, CA 90009

Topics #141-144

HQ AFSTC/XNE
Building 497, Room 122
Kirtland AFB NM 87117

Topics #145-153

AFWL/PRP
Building 497, Room 241
Kirtland AFB NM 87117

Topics #154-159

AFGL/XOP
Building 1107, Room 200
Hanscom AFB MA 01731

Topics #160-165

AFRPL/TSPR
Building 8353, Room 115
Edwards AFB CA 93523

Topics #166-174

RADC/DORM
Building 106, Room A112
(Attn: Mr. M. Donovan)
Griffiss AFB NY 13441

Topics #175-180

ESD/XRCT
MITRE D Building, Room 1D227
(Attn: Maj Stegmaier)
Hanscom AFB MA 01731

Topics #181-190

AD/PMR
Building 350, Room 428
Eglin AFB FL 32542

Topics #191-202

AFOSR/XOT
Building 410, Room A113
Bolling AFB DC 20332

Topics #203-209

HQ Aerospace Medical Division
AMD/RDO
Directorate of Resources and Operations
Building 150, Room 224
Brooks AFB TX 78235

Topic #210

AFRL/TSPR
Building 8353, Room 115
Edwards AFB CA 93523

Topics #211-215

AEDC/DOT
Building 900, Mail Stop 900
Arnold AFB TN 37389

Topics #216-218

HQ AFESC/RDXP
Building 1120
Tyndall AFB FL 32403

AF85-001 TITLE: Electro-Optical Power Supply

DESCRIPTION: The purpose of the power supply is to provide impedance matching, electromagnetic pulse (EMP) protection and a stable and reliable power source.
The power supply is made up of an electro luminescent lamp bonded to a series connected photovoltaic cell to provide five volts whenever the lamp is powered up. The lamp and cells may be made into as many layers as necessary to provide sufficient power to drive the circuit card. A regulator and capacitor may be needed to provide stable power.

EMP protection will be achieved because the lamp is a high impedance device, thus and surge coming through could go to ground.
This technique would provide a low cost power supply that would be compatible with the newer high-speed circuits. As a matter of fact, the power supply could be built into the printed circuit card, thus reducing the space required and improving the packaging efficiency.

AF85-002 TITLE: Low Temperatures, Low Pressure Water Separator

DESCRIPTION: The purpose of the water separator is to remove sub cooled water droplets from the environmental control system (ECS), air distribution system ducting in an aircraft. Present systems cannot operate at temperatures below or near freezing, i.e., +32°F to -10°F temperature range. The water droplets, mostly in the sub micron size range, form ice on any surface on which the impinge. If it were possible to remove the ice from the air stream, the performance of the ECS would be significantly enhanced.
The requirement is to remove all ice from the impingement surface and exhaust it overboard. Due to the lack of availability of energy, the use of some means of generating heat is not acceptable. A typical cooling system for a small/medium size aircraft has an airflow of 25 pounds per minute, which is the desired handling capacity of the separator. The size of the separator shall be less than 0.7 cubic feet.

AF85-003 TITLE: Electro luminescent (EL) Lamps to Achieve Higher Brightness, Longer Life, and More Uniform Light Output Over Time

DESCRIPTION: Electro luminescent lighting is an important source of illumination for a wide variety of Air Force requirements. It is being used for illumination of instrument panels, for flood lighting in cockpits and cargo areas, for runway lighting, for formation light son aircraft, etc. Green electro luminescent lighting is a compatible light source for use with night vision goggles (NVGs) and enables pilots and others to look at information displays and not cause interference with goggles.
Improvements in several areas would increase the possible applications for electro luminescent lamps: brighter EL lamps could be used in caution/warning and status indicators which require daylight readability. Presently, dual lighted displays are being used in aircraft that use NVGs, incandescent for daytime readability and EL for night and NVG compatibility. Additional work needs to be accomplished in EL lamp fabrication techniques to increase their producibility and the development of lamps with flatter life curves (present lamp light emissions decrease with time). Existing lamps have a useful life of approximately 6,000 hours at 115VAC 400Hz power.

AF85-004 TITLE: Brushless D.C. Motor for Mini-Drone Propulsion

DESCRIPTION: Recent advancements in battery energy density suggest that direct current (DC) brushless electric motors offer the potential of providing an ultra-reliable and long-term storable alternative to gasoline engines as to be available in late 1984. Present system estimates, that indicate a 3 to 4 hour mission duration, will be possible if the propulsion (electric motor) can be significantly improved.

The solid state, logic driven rotary device, called a “brushless DC motor,” is the first motor improvement in years that exhibits the lightweight and high power density necessary for efficient aircraft propulsion application. To date, these motors have not been produced in larger sizes (such as 10-20 horsepower) that have application for mini-drone propulsion use.

A motor design development effort is proposed that has two significant objectives. One, an instantaneous automatic motor logic control development that will respond to shaft loading and will hold maximum efficiency motor operation without any external input. Automatic servo control circuitry is not new but integration with brushless DC motor control logic is new and can be an innovative research effort. A drone that can climb, cruise, or dive and a motor that will respond with optimum power and proper shaft RPM will be new (i.e., no throttle or software stored throttle information). The other objectives are minimum size and weight in larger horsepower sizes. This objective has not been accomplished to date but is considered within the state of the art.

The objective of this effort is to develop and demonstrate a flyable motor and motor control system. The goals are a 10 horsepower system not to exceed 25 pounds total weight and a 20 horsepower system not to exceed 40 pounds. These systems must be able to replace existing gasoline engines for flight demonstration purposes.

AF85-005 TITLE: Feasibility of Automatic Direction Finding for Spread Spectrum Communications

DESCRIPTION: Automatic direction finding (ADF) is an adjunct to ultra-high frequency (UHF) radio communications. It has long been used for search and rescue of downed pilots and tanker rendezvous for air refueling missions. UHF/ADF equipment, such as the OA-8697/ARD, can process detected amplitude modulated audio (voice or tone) signals to provide relative bearing to the signal source. It accomplishes that by rotation of an antenna cardio id pattern that translates the spatial angle of an incident radio frequency signal into a phase difference between the antenna modulated output and a reference signal synchronous with antenna rotation.

Some radio systems now in development utlitize spread spectrum modulated RF signals to provide reliable radio communication in t he presence of electronic jamming. Present UHF/ADF equipment is not compatible with spread spectrum systems because the desired signal is not sorted from undesired signals until after correlation detection. Consequently, present UHF/ADF sets are not being considered for use with these new communication systems.

The objective of this effort is to perform a general feasibility study and analysis of the application of automatic direction finding systems to spread spectrum radio communication. Capabilities of ADF systems as a navigation aid must be determined while operating in a tactical communication, jamming environment.

AF85-006 TITLE: Test Equipment for Avionics Beyond 18 GHz

DESCRIPTION: The frequency range of developing and about to be fielded RF avionics equipment is expanding above 18 GHz. That avionics equipment will be maintained and calibrated (supported) under the same maintenance concepts and by the same people that support today's avionics. However, a quick review of test equipment catalogs reveals that there is not much test equipment for maintaining and calibrating avionics and test equipment that operate beyond 18 GHz. Research needs to be performed to determine:

a. What test equipment is presently available to support RV avionics operating above 18 GHz.
b. What test equipment, scheduled for release by January 1987, will be available to support avionics operating above 18 GHz.

In the past, it was correct to assume that a majority of the test equipment and test techniques or methods were available to support avionics systems that were being developed. Test equipment efforts were usually concerned with selecting the proper test equipment and integrating it into an efficient support system. The recent rapid exploitation of the RF spectrum beyond 18 GHz may mean that the assumption is no longer correct. If the research reveals that the development of test equipment rugged enough for military use has not kept pace with avionics development, then the research should also address:

a. What test equipment development efforts should be the subject of 6.3 developments in FY 86, 88, and 90?
b. What test equipment development efforts should be the subject of 6.4 developments in FY 86, 88, and 90?What peculiar test techniques, methods, and facilities are required to support RV avionics and test equipment that operate beyond 18 GHz?

AF85-007 TITLE: Continuous Production of Carbon Composites

DESCRIPTION: Carbon composites show great promise of producing next generation, high performance aircraft. Composites are very light, highly durable, and strong. The present process of producing composite material is a slow, manual process. A need exists to study the feasibility of devising a continuous production process for carbon composites. The research should consider all processes required to manufacture carbon composites from carbon fabric. Repairability features should also be addressed in terms of how the process could be adapted to repair composite material.

AF85-008 TITLE: Development of Innovative Advanced Performance Titanium Casting Alloys

DESCRIPTION: During the past decade, the use of titanium casting has advanced to the point where castings are now being used routinely in advanced airframe, engine, and missile applications. However, only conventional cast and wrought (ingot metallurgy) alloys are being used. It appears that a major unexplored area exists for development of alloys specifically for castings, in a similar manner to the alloys developed for the superalloy system about 12 years ago. Research should be conducted to evaluate the feasibility of alloying additions to titanium which would allow improved castability (reduced reaction with casting ceramics) while exhibiting mechanical properties at least equal to those now routinely attainable in conventional alloys. The research should include mechanical property evaluations, including those necessary to ensure structural integrity.

AF85-009 TITLE: Low Density Titanium Alloy Development

DESCRIPTION: The use of titanium alloys in advanced structural concepts is likely to decrease because the density of conventional titanium alloys is significantly higher than advanced composites and powder aluminum alloys. Research should be conducted to investigate the feasibility of developing a new class of titanium alloys with low density, which could approach that of conventional aluminum. Effects of production methods, fabrication techniques, and alloying additions should be included. Use of this new material would be contingent on acceptable mechanical properties, particularly fracture-related behavior such as fracture toughness and fatigue crack growth rate.

AF85-010 TITLE: Aeronautical System/Subsystem Innovative Concepts

DESCRIPTION: This category of innovative concepts is intended to cover all facets of aeronautical system/subsystem research, development, and procurement. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific aeronautical topics. This general area covers the full spectrum of Air Force aeronautical missions (i.e., tactical, airlift, mobility, strategic, transatmospherics, etc.). Proposals as diverse as new weapon system concepts and improved training techniques can be submitted. Some other areas of interest are high-energy fuels, maintenance free systems, facility threat, countermeasures, applications of artificial intelligence, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF85-011 TITLE: Cryo-magnetic Materials Research Program

DESCRIPTION: This topic is intended to establish a formal research effort in the general area of cryo-magnetic effects on altering and enhancing fundamental properties of materials for any type application. The feasibility research will include a survey of national/international activities in this area, and the identification of potential materials and properties of materials to be investigated. The research should include devices which provide temperatures to a few degrees above absolute zero to temperatures achievable by using the Peltier effect. Magnetic fields generated should be high density static as well as high density rotating fields. The products of this research effort would be recommendations for the requirements to establish research programs and requirements to implement such programs.

AF85-012 TITLE: Feasibility Study on Frequency Domain Target Signatures

DESCRIPTION: Current electro-optical techniques used to provide target recognition/identification require high resolution resulting in limited range or narrow field of view and are limited by weather, night, and foliage obscurity. Target recognition/identification techniques which utilize target data collected from electromagnetic sources covering the spectrum of power through microwave frequencies may provide increased capability. The measured sources could be cooperative, noon-cooperative, unintentional, or natural in origin. These frequency domain characterizations would be examined to determine the increased detectability of targets and their identification. The research would initially examine the scope of target related electromagnetic characteristics which, when collated, would yield target signatures, and would include factors such as dipole, tuned cavity effects, target generated energy due to operation, etc. The research would determine the feasibility of establishing a research program in the frequency domain area and its potential benefits.

AF85-013 TITLE: Transatmospheric Mission Sensor Technology

DESCRIPTION: This effort is to examine the unique and innovative approaches to vehicle sensor technology during the transatmospheric phase (100,000-500,000 ft) of its mission. The use of extendable/retractable sensor arrays for both electromagnetic as well as electro-optical sensors which permit greater performance in resolution, range, and power requirements than vehicle enclosed systems is an area of interest. Additionally, multimode arrays reconfigurable in the transatmospheric environment are another area of interest. A research proposal should result in a programmatic approach to systematically examining the entire area of sensors, with specific areas of promising potential for vehicles operating at altitudes in the range of 100,000-500,000 ft.

AF85-014 TITLE: Expert System Use of the Ada Interface to Other Computer Languages

DESCRIPTION: Expert System Software for airborne use will be installed in embedded computers working in a multitasking environment. Ada is the standard language for embedded computers, but by itself, may not be the most practicable or acceptable language for applying expert system technology. It may be necessary to use other languages such as LISP, PROLOG, Smalltalk, or Fourth. Because of this Ada interface to other languages feature, it is possible to adhere to the Ada standard and yet make use of these other specialized languages.

The interface to other languages specifies the calling conventions and informs the compiler that an object module will be supplied for the corresponding subprogram. This interface capability may not be provided by all Ada compilers.

There is a need for an expository report on t his Ada language feature as it relates to LISP, PROLOG, Smalltalk, and Fourth. This report would also include a qualitative evaluation of the utility and limitations of the interface to other languages feature. Optionally, the report may include a proposed method for the quantitative demonstration of the utility of the interface to other languages feature.

AF85-015 TITLE: Investigation of Concepts to Add Computer Aided Decision Devices (Artificial Intelligence) to the Tracking and Targeting Tasks of the Airborne Fire Control and Missile Systems

DESCRIPTION: The objective of this topic is to develop a computer aided decision device or software that will increase the kill probability of a weapon system. Currently, the only data that are transferred from the fire control system to the missile is in terms of “finite instruction.” It is believed that increased kill probability could be achieved by using the “if-then” instruction of the artificial intelligence type software program. Research is needed to combine these principles to develop a better total weapon system.

AF85-016 TITLE: Decontamination by Activated Oxygen

DESCRIPTION: Activated oxygen has the potential to break down certain compounds, namely organophosphorous compounds – chemical warfare agents. The feasibility of creating activated oxygen has been studied, but not the feasibility of generating large amounts for destruction of a large mass of compounds. The cost and complexity of materials and equipment necessary for generation of the gas must be investigated. Since activated oxygen is quite reactive, the effect on materials to be decontaminated is an important consideration. Activated oxygen must be compatible with most airbase materials, particularly aircraft and ground crew ensembles. The need for a quick decontamination method is driving this type of technology; therefore the time to completion of the reaction is a key question that needs to be answered.

AF85-017 TITLE: Development of an Interactive Computer-Aided Design for Analysis of Control Systems

DESCRIPTION: Many advanced aircraft designs with relaxed stability require methodology to synthesize and analyze control systems rapidly. Many software packages exist which can aid in performing control system analysis but unfortunately they are not set up to operate interactively. What is needed is an innovative approach which allows interactive computer-aided design and analysis of controllers and estimators for multi-variable systems. Both classical and modern control design techniques should be used, allowing for transformation between state space and frequency domain. Provisions should be included to accommodate the dimensional stability derivatives as inputs allowing for a transfer function and/or state space description. Also, the means to transform from physical variable state space description to various canonical representations is essential. As a minimum, the controller and observer form are necessary to conduct in-house analyses. Pole placement techniques should be part of this research. The software should also be able to utilize linear quadratic gaussian algorithms.

Also, a trajectory optimal control program for non-linear air vehicle equations of motion is required for both aerodynamic and thrust controls. The input format should allow a description which includes the vehicle aerodynamics as a function of mach and angle of attack, the weights, and propulsion data. The range and, in some cases,vehicle characteristics (e.g., thrust/weight, wing loading). Allowances should be made for equality constraints such as angle of attack and load factor. This methodology should also be available on a digital computer for interactive analysis. This interactive program must be compatible with the VAX/780 computer system.

AF85-018 TITLE: Tech Mod for Small Businesses Supplying Products to the Propulsion Sector

DESCRIPTION: The Tech Mod Program addresses the development, integration, and implementation of new manufacturing technology which can be applied to the propulsion sector. Small businesses which are currently either supplying machine tools or processing equipment to the propulsion sector or companies which are supplying parts and hardware to the propulsion sector are encouraged to submit proposals. The proposals may either relate to improvements which are or will be offered to the propulsion sector or improvements which are or will be implemented within the company offering the proposal and which will significantly reduce the cost of propulsion systems to the United States government. The types of work included in Tech Mod are study, development, and implementation efforts relating to:

a. enabling technology;
b. design of material handling, storage, and movement systems;
c. design of special tools, test equipment, and inspection equipment;
d. design and integration of factory layout and work cells;
e. qualification of new processes, cells, and work centers;
f. qualification of hardware produced by new processes;
g. integration of new technology into the production systems; and
h. management information systems (internal to the company only).

AF85-019 TITLE: Gallium Arsenide (GaAs) Device

DESCRIPTION: Research is needed to understand better the physics of GaAs device and circuit operation. These devices and circuits are needed for avionics, missile and space applications. Such devices provide ultra high speed digital data rates, and recently clock rates of 10.0 gigahertz at 77°K were observed. Higher speed circuits allow fabrication of radar systems with improved performance characteristics. Consequently, DoD and especially the Air Force have programs to develop GaAs technology. The purpose of this research is to supplement and enhance the development of GaAs technology. Of prime interest is work on Modulation Doped FET, since this represents a new and extremely promising technology. Other areas of interest are insulated-gate GaAs field effect transistor technology, bipolar heterojunction transitor technology, and MESFET technology. Theoretical, analytical or device and circuit fabrication efforts are of interest to develop further the above indicated technologies. Theoretical research may include two-dimensional device modeling, evaluation of ballistic effects, velocity overshoot effects, gun domain formation, and circuit simulation. Analytical work may include materials evaluation by Auger spectroscopy, Rutherford backscattering, etc. Finally, transistors and circuits could be designed, fabricated, and tested. The above description maps out a wide area of interest and the anticipated program would attack a small segment of this above described area. Proposals addressing individual area will be considered.

AF85-020 TITLE: Artificial Intelligence (AI) Development for Pilot Aid Applications

DESCRIPTION: Over the past decade avionics systems have evolved dramatically from the bare essentials of radio and radar, which required minimal crew work-load to maintain and operate, to the complex systems of today, which greatly enhance the effectiveness of the aircraft. However, unless something is done to assist the pilot in the operation and supervision of these complex systems, the airplanes of the near future will fall short of achieving their full potential effectiveness. For that reason, an extensive program in the field of artificial intelligence is planned with which to make complex systems smarter, and thus easier for the pilot to interact. All aspects of artificial intelligence will eventually be addressed to seek potential solutions for the avionics complexity problem under this program; however, present areas of interest are focused on the real time environment of the cockpit where new data are constantly acquired and acted upon to insure that mission goals are achieved.
In the view of the above, research is need in the following areas:

1. Development of “real time” inference systems which can deal with multiple opponent aircraft and predict/estimate the intentions and capabilities of each opponent as well as the collective expected result of their observed actions. Develop “real time” adaptive learning techniques which could automatically update established knowledge bases in the even that expected behavior-capability results deviated from actual behavior-capability results.
2. Develop “real time” artificial intelligence techniques algorithms to recognize what knowledge is relevant to the curren tcombat situation. Develop “real time” artificial intelligence techniques that can 1. use default assumptions, and 2. reason given incomplete information, and 3. tolerate inconsistent data.
3. Develop “real time” artificial intelligence knowledge-based signal interpretation systems that can integrate a large amount of data from sensors and can translate those data into knowledge for other system components to use.
4. Determine the attributes and tradeoffs of LISP versus Prolog as an artificial intelligence language for “real time” military environment applications.

AF85-021 TITLE: Compound Semiconductor Research

DESCRIPTION: Thin layers of semi conducting material with very sharp interfaces have been shown to have a number of properties that are very interesting to the Air Force. Specific device concepts employing these structures are under development, and basic research to support those developments is underway. Primary interest at this time is in the GaAs/AlGaAs system, but other materials will become of interest as they show significant advantages. At the present time, molecular beam epitaxy (MBE) and metal organic chemical vapor deposition (MOCVD) are the primary methods used to grow the thin structures, and there is interest in programs to improve these two techniques or in other techniques that might be better. New physical principles govern the performance of the new class of devices that is evolving and new measurement techniques or variations of established techniques are needed to understand the materials properties that control that performance. Research to show the connection between the

material characteristics and device performance is also of interest. Examples of research that would be of interest are: 1. development of experimental techniques to measure interface sharpness between layers of GaAs an AlGaAs to within a half of a lattice constant; 2. development of way of determining carrier concentration profiles within 100 A of an interface; 3. development of measurement techniques that would give impurity and defect profiles close to interfaces for both residual and doping concentrations; and 4. research of unique characteristics that would have a significant impact on present or new device concepts. Theoretical research to develop models of the materials properties of thin structures and devices fabricated from those structures is also of interest.

AF85-022 TITLE: Communications Jamming Threat Simulation

DESCRIPTION: The primary objective of this program is to define requirements and develop hardware/software design specifications for hardware simulation of the tactical communications jamming threat projected for the 1990's.

The desired simulation capability will be used to evaluate the operational performance of USAF advanced tactical communication system developments. The technical effort should include: 1. identification and detailed description of the projected tactical communications jammers; 2. system level design of the simulation for the jamming threat projected against a selected USAF tactical communications system; 3. if feasible within available resources, implementation of the designs for one or more of the jammers considered under 4. This implementation will be accomplished using Radio Frequency (RF) signal generation hardware currently resident within the sponsoring organization; and 5. validation of the selected jamming signal generation implementation via a hardware Communications Electronic Counter Counter Measures (ECCM) susceptibility demonstration. Innovative, low-cost approaches, taking maximum advantage of off-the-shelf hardware/software is preferred.

Interested parties may obtain a list of the RF generation hardware referenced in task 4 by contacting the sponsoring organization.

AF85-023 TITLE: Computer Operating System Instruction Set Primitives for Ada

DESCRIPTION: The increasing use of real-time multi-tasking software operating systems for avionics computer applications has resulted in the situation where the operating system overhead consumes a significant portion of system through-put. Much os this overhead results from the fact that an application software call on the operating system normally results in a nested set of context switches through a series of software macro-instruction procedures and/or subroutines. In theory, operating system overhead could be decreased by conversion of all operating system primitive procedures into actual processor instructions by microcode techniques. Some examples of this conversion would be unitary instructions for handling data structures such as queues, linked-lists, and binary threaded trees. Other examples might include unitary instructions for system resource allocation such as "Get-Memory-Block" or "Get-Input/Output-Channel." In practice, such structuring of the operating system could be incompatible with the use of higher order languages such as Ada. This work would determine what "operating-system-instructions" would be compatible with an Ada programming environment and evaluate the feasibility of implementation.

AF85-024 TITLE: Built-in-Avionics Software Test Device

DESCRIPTION: Aircraft flight safety and mission effectiveness is increasingly dependent on computer-based avionics systems. As a result, there is increasing use of real-time fault-tolerant multi-tasking multi-processor systems where faulted processor nodes are placed off-line. Fault detection and real-time confidence testing are the keys to this type of approach. Current approaches to fault detection and confidence testing are based on built-in hardware test logic, the use of watchdog timers on software processes, and on t he execution of diagnostic software as a processor background task. Built-in hardware tests do not test "system-health." Watchdog timers and diagnostic software consume processor resource capabilities. It is theoretically possible to develop a device that would reside on a processor system bus and that would perform fault-detection/isolation and confidence testing by passively monitoring system bus communications with signature analysis techniques. This work would determine the parameters of such a device and evaluate the feasibility of developing this device.

AF85-025 TITLE: Characterization of GaAs IMPATT Diodes for Active Aperture Applications

DESCRIPTION: The objective of this program is to determine the applicability of gallium arsenide (GaAs) impact ionization avalanche transit time (IMPATT) diodes to satellite active aperture communications systems. Through analysis, the research shall investigate various types of spatially combined IMPATT amplifier configurations (e.g. binary corporate, M-ARY corporate, paralleled) and determine the power level, gain, amplitude and phase tracking, efficiency, and bandwidth requirements for the IMPATT diodes. The research should then experimentally characterize and measure the GaAs IMPATTs to determine if these devices can meet the active aperture systems requirements.
Spaceborne environmental constraints such as temperature, 10-year mission life, etc., shall be considered in this effort. The analysis and experimental measurements for this program shall be conducted based upon the transmit active aperture system requirements model presented below. The active aperture operating frequency range is 20.2 to 21.2 GHz; the minimum EIRP is 50dBW (beam steered) and 45 dBW (EC beam switched); the half power beam width is 1.2 to 1.5 degrees; the polarization is LHCP; the axial ratio over scan volume is 3dB; the cross polarization relative to principal polarization is –20dB; the sidelobes within plus and minus 3 degrees of equatorial plane and over subtended earth angles are –20dB relative to peak; the antenna input power is +10dBm at 1dB compression; the beam reposition/settling time is 1 microsecond maximum; the amplifier temperature range is -15°C to +55°C; the channel phase response (deviation from linear phase) is +10° over total band and -5° over any 100 MHz; the third-order intermodulation products for FDMA operation are –10 dBc at rated power, -20 dBc at 13 dB backoff and –20 Bc at 6 dB backoff; the DC input power including DC power supply, beam beam steering computer, etc. shall be 300W maximum; and the scan volume shall be earth coverage.

AF85-026 TITLE: Tailored Expert System Generator

DESCRIPTION: It is theoretically possible to design an expert system which would then be capable of designing an expert system. This would greatly reduce lead time in introducing artificial intelligence used as an electronic combat aid to pilots in the tactical aircraft environment. Numerous systems, such as electronic countermeasures expert systems, speech control of avionics, reconnaissance systems, and target recognizers would benefit from reduced development time. The generic expert system could develop criteria and logic to define the expert system needed on a specific application. Given the system requirements, the generic generator would develop and organize the logic needed to work in a particular application, much as a computer-aided design enables engineers to test many designs prior to prototyping. This system, however, would contain the necessary prompts that would direct designer efforts such that, when completed, the output would be an expert system tailored to a specific application. This work would determine the feasibility of such a device.

AF85-027 TITLE: Dynamic Range Limitations of Acousto-Optic Spectrum Analyzers

DESCRIPTION: Acousto-optic spectrum analyzers are very attractive for application in electronic warfare RF receiver systems because of their potential small size, low cost, and high reliability. However, to be utilized they must meet stringent requirements for two-tone dynamic range. This refers to the ability of the system to detect a small signal in the presence of a large one. This is in part limited by the presence of spurious signals associated with optical crosstalk. Examples of factors contributing to optical crosstalk are scattering, aberrations, sidelobes, and spontaneous emission in the laser source. The purpose of this proposed effort is to assess the system performance limits imposed by the above factors and to suggest approaches for minimizing their effects. Theoretical models are to be developed that relate optical quality of components of miniature acousto-optic spectrum analyzers to system performance. Some experimentation may be appropriate to guide the theoretical analysis and confirm the theoretical model. It is expected that the theoretical findings will suggest approaches for the development of acousto-optic spectrum analyzers with significantly improved dynamic range.

AF85-028 TITLE: Fluorescent Flash Lamp Envelopes

DESCRIPTION: Nd:YAG is extensively used in military laser applications but improvements in efficiency of operation are needed. Nd:YAG rods are typically pumped optically with xenon-filled quartz envelope flash lamps.

But the emission spectrum of xenon is not a good match with the Nd:YAG absorption bands resulting in poor energy transfer. Some attempts have been made to use fluorescence converters (materials which absorb flash lamp radiation and re-emit at wavelengths absorbed by Nd:YAG) to improve Nd:YAG lasing efficiency with less than impressive results. One fluorescence converter geometry that deserves further consideration is incorporation of a fluorescence converter (such as Ti3+:Al2O3) into the flash lamp envelope. Optimization of spectral output for efficient Nd:YAG pumping without a reduction in flash lamp lifetime is desired. In addition, a means by which the envelope fluorescence can be efficiently transmitted out of the envelope and into the laser material is needed. Efficient extraction of light originating in the fluorescent converter is difficult since emission occurs in all directions, many of which will trap the radiation due to total internal reflection (TIR). New concepts for using fluorescent converters in flash lamp envelopes with increased optical pumping efficiency while minimizing TIR are needed.

AF85-029 TITLE: Frequency Doubling Tunable Laser Output Technology

DESCRIPTION: Solid state laser materials such alexandrite and titanium doped sapphire have recently been shown to have continuously tunable output in the red to near-infrared region. Frequency doubling technology currently involves orienting a doubling crystal for efficient conversion of a discrete and constant wavelength input. In the case of a tunable laser where rapid wavelength changes may be desired, the doubling crystal orientation must track the incoming fundamental wavelength. Research is needed to identify appropriate approaches and techniques for automated operation of a wavelength-following doubler. A wavelength switching response of less than 100 microseconds is desired with greater than 30% conversion efficiency over at least a 100 nm spectral range.

AF85-030 TITLE: Stability and Control Research for Super maneuverability

DESCRIPTION: Most current high-performance combat aircraft are unable to operate effectively near the extremes of the flight envelope. A comprehensive program aimed at removing these deficiencies will significantly enhance the combat capabilities of advanced fighters.

Initially it would be useful to extend the simple analytical aerodynamic tools used at lower angles of attack to the highly nonlinear range, resulting in methods such as nonlinear panel methods, nonlinear lifting line, slender body with vortex interaction, and interactive boundary layer methods. Some such methods already exist but are in need of rigorous correlation with experiment. Also, the effects of aerodynamic lags throughout the flight envelope need to be better determined. Such efforts would lead to rational design methods for a controllable super maneuverable aircraft.

AF85-031 TITLE: Use of Holographic Optics to Demonstrate the Feasibility of Aircraft Head Up Color Displays

DESCRIPTION: The major obstacle to the development of aircraft head up color displays has been the need for very high cathode ray tube brightness necessary to compensate for conventional optic beam splitter inefficiencies. With the use of holographic combiners with higher efficiencies this obstacle is fast diminishing. The purpose of this effort will be 1. to use computer techniques to evaluate phosphor/hologram design combinations for application to head up color displays, and 2. to build a head up two color display demonstrator and 3. to propose a design for a head up full color display for future development.

AF85-032 TITLE: Application of Artificial Intelligence (AI)

DESCRIPTION: Reconfiguration shows great promise of being able to significantly increase the damage/fault tolerance of flight control (FC) systems. This is done by utilizing other FC surfaces to reconstruct the forces and moments after a surface failure. There are a number of techniques or strategies for doing this.

The role of identification is of fundamental importance in flight control system reconfiguration. A control law is based upon a model of the aircraft, and if the aircraft deviates from the model due to failure beyond specified limits, the control law is no longer valid. By measuring the failure effects, the identification scheme attempts to estimate the new parameter values, and the new model is then used to define a new control law. However, this "adaptive" technique has a fundamental problem – false identification. Identification techniques have varying degrees of sensitivity to noise, disturbance, and other inputs. It is sensible to minimize the use of identification in areas where false identification has serious implications. The purpose of this project is to develop a concept for robust design of a reconfiguration strategy using AI. The ability of the AI to accurately model the new aircraft characteristics in the presence of noise disturbances, initial conditions, and other inputs would be evaluated. The role of AI in reconstructing lost forces and moments would be investigated.

AF85-033 TITLE: Non-Invasive Electromagnetic Field Sensor

DESCRIPTION: Certain materials change their physical properties in the presence of electromagnetic fields. If the material maintains this change when removed from the electromagnetic field, it may be possible to develop a non-invasive field sensor.

For example, anisotropic crystals have been used to split laser beams, in chop laser pulsers and as electrical switches. Placing these crystals in an electric field results in a change in their conductivity tensor; however, removal from the electric field results in the immediate return to ground state. A crystal with a longer relaxation time could be used as a sensor to provide information on the characteristics of the impressed electric field.
Research should be conducted to determine if such materials exist or can be developed.
A sensor utilizing this material would provide a non-invasive electro-magnetic field measurement and would have application in the NEMP and lighting research areas.

AF85-034 TITLE: Protective Field Feasibility Study

DESCRIPTION: It is estimated that in future battle scenarios, our aircraft will be flying against heavy artillery fire, including surface-to-air, and other anti-aircraft ordnance. Current protection techniques used to reduce the aircraft's vulnerability to such threats include the application of various types of foam, armor, and self-sealing materials. These techniques reduce the damage incurred by the aircraft through the alleviation of the damage mechanism or the damage potential of the fragment or projectile after it enter the aircraft's skin.

It is conceivable that an even greater level of protection may be achieved if a protective field enveloped the aircraft. This protective field would either defeat or deflect the incoming threat and prevent it from entering the aircraft. This type of system would not only have the advantage of being a single system to maintain, as opposed to the various independent techniques currently used, but would also possess a multiple shot capability.
The feasibility of this concept needs to be studied. Energy and hardware requirements need to be determined, along with the evaluation of this concept's potential (i.e. atmospheric, space, or chemical-biological and applications), to firmly establish whether the objectives are attainable or if additional work is justifiable. It is believed that initially only a limited number of work is justifiable. It is believed that initially only a limited number of threats may be affected by this concept. But with additional research development efforts, future advances would be made. Factors may be discovered prohibiting the concept's use on-board an aircraft (i.e. avionics equipment interference), but allowing its application on land or sea vehicles and structures. The potential uses for this passive defense concept are unlimited.

AF85-035 TITLE: Spacecraft Heat Rejection Methods

DESCRIPTION: Heat dissipated from electronic boxes and other equipment on orbiting satellites must ultimately be rejected by thermal radiation to space. Coated aluminum panels are often used for this type of radiator. Heat pipes or circulating fluid loops may be included to help distribute the thermal energy in the radiator panel. This provides adequate heat rejection for present day satellites. However, the much higher heat loads expected on future satellites

will cause the radiator panels to become a large part of the total satellite mass, and their size will effect spacecraft stability and configuration. A better method of heat rejection is needed.

Research and development is needed to explore innovative design approaches for spacecraft heat rejection subsystems. Heat must be transferred from equipment at approximately room temperature and ultimately rejected from the satellite. Weight, size, and power consumption all need to be considered as well as maintenance of high cleanliness condition for sensitive instruments. Total heat loads may range from five kilowatts to 100 kilowatts, and the system must operate for five to ten years in space. Phase I analysis should be adequate to determine the feasibility of any new technical approach and should establish the type of development which might be needed for eventual spacecraft implementation of the concept.

AF85-036 TITLE: Innovative Tactics for Air Combat Simulation

DESCRIPTION: Multiple vehicle air combat analysis is currently being used to develop combat sensitive on a digital computer. The results from such simulations are used as an important factor affecting decisions which impact current and future systems characteristics. The heart of combat simulation models are the tactics used which, in turn, drives the results and sensitivities. Current models tend to rely on tactics selected by a decision tree or logic based on relative positions of the various force elements. This effort is to investigate the potential of applying innovative techniques such as learning theory and artificial intelligence to the generation of tactics.

The intial need in this area is to determine what methods are available and the suitability of different approaches. Desired results from this work would be a tactics generation computer model which can be applied to existing air combat simulation programs. It is desired that as part of this effort the model be programmed, tested, and its suitability and feasibility assessed.

AF85-037 TITLE: Improve the Aerodynamic Heating and General Boundary Layer Computations of the Parabolized Navier-Stokes (PNS) Code

DESCRIPTION: Three-dimensional boundary layers are evaluated by the PNS code from the fundamental computations. Extracting final data on skin friction and heat transfer as well as accurately evaluating the boundary layer parameters requires fundamental understanding of advanced viscous flow theory as well as a working knowledge of numerical flow field codes. The current code has rudimentary concepts imbedded in it which require engineering attention and significant updating. This job is to re-work the application of advanced boundary layer theory to the PNS computational output and upgrade the quality of the resultant engineering information.

AF85-038 TITLE: Particle Sizing Detection System

DESCRIPTION: Currently, the laser velocimeter (LV)/anemometer technique for flow velocity measurement requires that light be reflected from so called “scattering centers.” It is this light that is processed through an optical/electronic detection system to obtain velocity. In most practical cases (actual wind tunnels and flow channels), the natural distribution of seed material is usually not known nor of correct size and does not exist in sufficient quantity. Since natural seed is not useable, seed material is introduced into the flow by a variety of devices, generically referred to as seeders. The size distribution of this seed material must be accurately known so as to project a confidence level that the seed is following the fluid dynamic features of the flow in question. The size region of interest for most LV work is in the range of 0.3 to 3.0 m. Current particle sizers and counters do not allow an in-situ measurement or a measurement during facility operation. What is needed is a system/technique which will provide for, at minimum, particle sizing and count in the environment in question, preferable with the fluid dynamic facility in operation.

AF85-039 TITLE: Passive Vulnerability Reduction to Hostile Threats

DESCRIPTION: Fuel Fires and explosions from hits to the aircraft fuel system by incendiary and high energy ballistic projectiles and warhead fragments have been the greatest single cause of aircraft loss in past air wars. Many approaches reducing the vulnerability of fuel systems have been proposed but result in penalties to aircraft performance operating costs because of excessive weight, volume, or maintenance characteristics.

Innovative concepts or techniques are sought which could prove effective in reducing the combat fuel fire and explosion threat in fuel tank void spaces or dry bays adjacent to tanks without the performance or cost penalties of current state of the art.

AF85-040 TITLE: Trans-Laminar Reinforcement or Organic Matrix Composite

DESCRIPTION: There are a variety of design situations where it would be very advantageous to provide reinforcement normal to the plane of composite plates. Without such reinforcement, composites are very weak in that direction, limiting some designs to low stress levels which could be increased if reinforcements were provided. The most widely used method of providing this reinforcement today is by stitching the uncured laminate with either graphite or Kevlar "thread," but there are a number of drawbacks to this technique, since it requires the use of a relatively large needle, causing damage to the laminate. Stitching is also rather costly if large areas are to be reinforced.

It is desired to investigate innovative technologies (other than stitching) for the trans-laminar reinforcement of organic matrix composites. One approach might be to insert short boron fibers into the uncured laminate using a roller which would insert the fivers into the laminate as it was rolled along the surface. Other techniques are encouraged. A feasibility demonstration should be performed on the method of inserting the reinforcement and a modest test program performed to demonstrate the increase in laminate properties resulting from the reinforcement.

AF85-041 TITLE: Improved Nondestructive Evaluation

DESCRIPTION: Nondestructive evaluation plays a major role in the production, operational safety, and maintenance of Air Force systems. Current emphasis has largely been on the inspection of airframe and engine components, sub-assemblies, and entire systems during manufacture and throughout their service lives as a major element of maintenance and repair procedures. The tremendous variations encountered in the articles to be inspected, in matters such as geometry, material composition, service conditions, and defect detection requirements, has led to the study of many physical, chemical, and mechanical phenomena which can be used as inspection techniques. Approaches are needed for improved NDA technigues for the detection and characterization of flaws in airframe and engine materials including metals, composites, and ceramics, in electronic device materials and components, and also for the realtime monitoring and control of manufacturing processes. In particular, research is needed on electromagnetic, ultrasonic, radiographic, and new and improved methods for the detection of bulk and surface defects in metals and composites field level examination of surfaces prior to adhesive bonding, as well as determination of resin and moisture content in advanced composites, imperfections in material coating, and corrosion. Of particular interest are those efforts which give an improvement in the reliability of the inspection process which allow the quantitative characterization of the flaws.

AF85-042 TITLE: Improved Aluminum, Titanium, and Magnesium Alloys

DESCRIPTION: New approaches leading to improved rapid solidification technology (RST) for aluminum, titanium, and magnesium alloys are needed.

Current Air Force interest in aluminum alloys centers around three families of alloys, namely high strength/corrosion resistant alloys, high modulus/low density alloys and elevated temperature aluminum alloys. Included is the response of these alloys to various types of processing, e.g., consolidation, forging, extrusion, and rolling. A particular area of interest encompasses development of innovative methods that lead to products with

RST microstructures, but at a substantially reduced cost. Current interest areas include technology for can less billet making, spray forming processes, and processes that are capable of producing RST sheet and component shapes directly from powders of the melt.

Titanium alloy requirements through rapid solidification technology (RST) are directed to the development of alloys with improvements in three areas: temperature stability to 1400°F, strength to 210 Ksi, and higher modulus/density ratio for use in advanced engine and airframe applications. Approaches are needed in alloy development, powder making ani powder compaction. A special interest is in new approaches to the innovative direct production of alloy powder, containing unique microstructure from inexpensive chemical reactants.

Because of good specific strength and stiffness, magnesium alloys are potentially attractive for many aerospace applications. Research is now needed to explore property improvements, especially in the corrosion resistance of these alloys that may be obtained using rapid solidification technology (RST). In addition, improvements in strength, stiffness, and even a reduction in density may be possible using increased levels of conventional additions and/or novel alloying additions. Approaches are needed in the following areas: development of a rapid solidification process suitable for Mg alloys, Mg alloy development, low cost consolidation techniques, and evaluation of mechanical properties.

AF85-043 TITLE: Reliable High Temperature Materials for Advanced Gas Turbines

DESCRIPTION: In Air Force turbine engines, materials are operating at or near their capacity with regard to stress, temperature and environment. Yet, it is necessary to extend the life of current systems. New systems are envisioned which will demand lighter-weight structures of extreme reliability and resistance to environmental attack or catastrophic failures. A rational basis for developing improved material systems (high temperature and refractory alloys, ceramics, or refractory composites) is required through understanding of the principles that govern properties and behavior as functions of micro structural features, composition, and processing. New approaches leading to increased performance of high temperature alloys, ceramics or refractory composites, are required as follows:

High Temperature Alloys. Approaches to thermodynamically stable oxidation-resistant turbine engine blade, vane, and disk, alloys which offer significantly improved creep, fatigue, and oxidation properties.

Ceramics. Research to identify new families of high performance ceramics or composite materials capable of economical consolidation, reproducible processing and improved thermal stress and fracture reliability is needed to extend the limits of future generation high temperature turbine engine components.

Composites. Approaches to improved oxidation resistant carbon-carbon and ceramic composites for use above 3000°F are required.

AF85-044 TITLE: Silahydrocarbon Research

DESCRIPTION: The Air Force is interested in approaches to develop thermally stable, wide-liquid range base fluids for hydraulic fluid and lubricant use, with chemical and physical properties equivalent or superior to the silahydrocarbons (tetraalkylsilanes), (Reference 1-3) but which are capable of being synthesized by chemical processes capable of producing these fluids in the 50,000 gallon or higher per year volume range for significantly less cost than the estimated $80 per gallon cost of the silahydrocarbon. Alternative synthetic routes must be explained and justified. For any alternative classes of fluids proposed, data or rationale must explain or show why their properties would be equivalent to the silahydrocarbons. Samples of candidate fluids synthesized must be characterized for viscosity, temperature and thermal stability properties and 250 ml samples of up to six of the more promising candidate fluids shall be submitted to the Air Force for further characterization. Ref. 1 “Synthesis and Characterization of Silahydrocarbons – A Class of Thermally Stable Wide-Liquid Range Functional Fluids,” Snyder, Jr., C.E. et al., ASLE Transactions Vol. 25, 3, 299-308. Ref. 2 “Determination of Storage Stability of Hydraulic Fluids for Use in Missiles,” Gschwender, L. et al., ASLE Preprint No. 83-AM-1A-1. Ref. 3 “Synthesis and Properties of Silahydrocarbon, A Class of Thermally Stable,, Wide Liquid Range Fluids,” Tamborski, C. et al., I&EC Product Research & Development 1983, 22 172.

AF85-045 TITLE: Protective Coatings for Aircraft Transparencies

DESCRIPTION: Protective coatings for aircraft transparencies, when subjected to thermal and environmental stress, tend to fail by peeling away from their substrate. However, a protective coating with the ability to form a gradually interdiffused boundary layer would not be expected to suffer from this defect. No clear boundary between the polymeric coating and the polymeric substrate would exist. Rather, a gradual transition in polymer chemical structure with an attending gradual transition in physical properties would be expected. Requirements exist for a polymer to serve as the basis of such a coating which would be compatible with high impact polymer substrates, (i.e., polycarbonates) possess thermal and environmental stability and have all the optical properties required of an aircraft transparency.

AF85-046 TITLE: Novel Monomer Precursor Chemistry

DESCRIPTION: High technology is needed to broaden the temperature range of high temperature, chemical, and fluid resistant compositions with potential for elastomeric application. The temperature range of -100°C to 400°C is possible within emerging technology. Specifically, the fluorocarbon ethers and fluorine – carbon – nitrogen polymer systems have the low temperature flexibility in the -100°C range and thermal stability above 200°C. Attempts have been made to prepare these types of polymers with marginal success. Novel approaches are needed for monomer precursor chemistry that will lead to a viable polymerization, yielding high molecular weight linear polymers. Initial considerations will not be limited to cost or toxicity, but these factors will need to be verified.

AF85-047 TITLE: Applications of Biotechnology

DESCRIPTION: The Air Force is interested in research and development directed toward applications of biotechnology to materials requirements. This activity can include the following areas:

Biosynthetic methods to provide state-of-the-art materials for Air Force structural, fluid, or electronic applications, utilizing resources which can be domestically produced.

Novel materials obtained from biological sources with properties which may satisfy current or future Air Force needs.

Biodegradation techniques appropriate to applications such as paint stripping or integrated circuit etching.

AF85-048 TITLE: Long Shelf Life Fiber/Resin Prepregs and Adhesive Films

DESCRIPTION: Long shelf life prepregs and adhesive films are required for use in repair fo composite components at the base and field level where refrigeration may not be available and materials consumption sporadic. This requirement might, for example, be satisfied by a feasibility demonstration of the use of encapsulation techniques to prepare long shelf life prepregs and adhesive films from conventional, commercially available materials formulations. Encapsulant materials selection and wall thickness would be critical so that the materials may be mixed into the MY720 (CIBA GEIGY) epoxy resin in conventional blenders at temperatures of about 130°F to 160°F without breakdown and subsequent reaction so that shelf life is not impaired yet the encapsulant should allow normal rates of reaction to occur during cure cycles beginning at about 200 to 250°F. The materials to be encapsulated could include solids such as DADS (diaminodiphenysulfone). It is imperative that the encapsulant materials not interfere with the cure of the resin or adhesive formulaton nor should it degrade the mechanical properties of the cured materials. Long shelf life formulations should be prepared from the various encapsulated ingredients and evaluated for storage life at various temperatures and humiditites, cure reaction kinetics, processing theology, and mechanical and chemical properties.

AF85-049 TITLE: Processing Science of Organic Resin Matrix Composites

DESCRIPTION: The Air Force is interested in approaches towards controlling the processing of organic resin matrix composites. This research and development can include the following areas:

Characterization of the processing behavior of resins as a function of critical materials and process parameters.

Modeling of the critical materials – processing interactions.

Development of novel techniques to control the materials and processes, including in-process sensing.

Validation of results through preparation of materials and processing into material forms and composites.

AF85-050 TITLE: Synthesis of New Thermooxidatively Stable Polymer Systems

DESCRIPTION: Approaches are needed for the synthesis and characterization of thermooxidatively stable polymeric materials specifically tailored in molecular structure for new, improved matrix resins and adhesives. Included are a. high molecular weight processable polymers exhibiting high thermooxidative stability which by virtue of chemical additions, cycloadditions or rearrangements can be cured to high strength materials, b. polymers containing a high degree of chain rigidity which can be ordered (and/or oriented) and processed to high strength materials, c. reactive oligomers capable of being converted to environmentally resistant, high molecular weight, high glass transition temperature materials by controlled chemical addition reactions and/or molecular rearrangements, and d. lowpolymers or prepolymers which can, without the production of by-products, be cross-linked chemically and/or through low energy cures to high polymer networks with excellent resistance to thermo chemical and mechanical environments and stresses. This also includes approaches to provide improved new polymer forming reactions and approaches to the synthesis of specifically structured chemical intermediates, multifunctional monomers and cross-linking agents required to produce the above polymeric materials.

AF85-051 TITLE: Organic Matrix Materials for Composites Structures for Space Applications

DESCRIPTION: The Air Force is interested in identifying and characterizing composite matrix materials for space applications. This research can include the following areas.
Identify and characterize composite matrix materials that exhibit neither moisture absorption during endoatmospheric processing, nor out gassing of trapped volatiles during exoatmospheric service conditions.

Develop new composite matrix materials that have aforementioned characteristics, and that possess epoxy-like processing capabilities.

Study the long term effects of outgassing on the dimensional stability of composite structures in the space environment.

AF85-052 TITLE: High Strength Carbon-Carbon Materials

DESCRIPTION: The Air Force has a requirement for high strength carbon-carbon composites for satellite structures, gas turbine components, and other applications. Improved shear and cross ply tensile strength in fabric laminate carbon-carbon composites is needed to provide better design flexibility with these high-temperature materials by eliminating the necessity of designing to low interlaminar strength allowables which are inherent with today's materials. This is particularly important to the Air Force in the design of gas turbine rotors and other applications where thin sections are required and the use of multidirectional weaves is not practical because of fiver tensile strength losses or coating difficulties. Solution to this problem may come from an understanding of fiber-matrix association leading to the ability to select constituent fiber and matrix materials and process them to achieve

an optimum fibre-matrix association without degrading other excellent properties. The potential of new small effective diameter fibers with high strength and stiffness should also be considered.

AF85-053 TITLE: Advanced Tribological Materials

DESCRIPTION: The Air Force is interested in research to develop self-lubricating materials for use a s face-riding seal materials in engines. These self lubricating materials may be reinforced internally to meet the necessary strength requirements. The use of innovative materials and/or preparation of these materials is encouraged. The materials are to provide self-lubrication (controlled wear rate) with limited fluid leakage at rest and at sliding up to 160 ft/sec with differential pressures up to 120 psi. The fluids to be sealed would include hydrocarbon oils and oil vapors. The temperature of operation would be in the range of 20°C to 550°C. Operation of these sealing materials would generally be against a counterface of titanium, but demonstration against alternate counterfaces would be considered and encouraged.

AF85-054 TITLE: Metal Matrix Composites

DESCRIPTION: Graphite-magnesium and graphite-aluminum metal matrix composites offer significant potential for high performance light weight spacecraft structures because of their stiffness and dimensional stability. However, practical manufacturing techniques for forming materials and structures are lacking.

Innovative ideas are needed in the areas of processing concepts for making tape or sheet and of fabrication of large components.

AF85-055 TITLE: Life Prediction for Engine Materials

DESCRIPTION: Prediction of fatigue and crack growth characteristics and development of cumulative damage models for elevated temperature metals and intermetallic materials and refractory composites which consider time-dependent behavior and environmental effects are required as a basic building block for life prediction. These models should be derived from laboratory-size specimens, with and without stress concentrations. Effects of mean stress, positive and negative stress ratios, combined stresses, overloads, rate and frequency of loading, hold time, and load sequencing need to be investigated. Effects of defects and application of threshold concepts should be considered. Particular interests are in property-microstructure relationships for materials for advanced turbine engines including nickel-base superalloys, sing crystals, and aluminides and refractory composites. Approaches are needed to provide these capabilities in an economic way.

AF85-056 TITLE: Surface Modified Transparent Plastics

DESCRIPTION: Transparent materials such as the acrylics and polycarbonates utilized in aircraft windshields and windows are degraded by the aggressive conditions of exposure to the sun and atmosphere as well as by inadvertent use of fluids which tend to degrade these materials.

This requirement involves a feasibility demonstration of the use of surface fluoration as a means of preventing stress crazing and cracking of acrylic and polycarbonate transparent plastics. Process variables including fluorination levels, depth of penetration, position of the fluorine on the molecular chain of the plastic and reaction conditions shall be investigated to determine the level of chemical protection that is achievable via this process. Specimens having various levels of surface modification shall be evaluated by stressed exposure to sunlight, humidity and various aggressive solvents and chemicals and subsequent mechanical test to determine resistance to stress crazing, cracking, transparency retention and mechanical properties.

AF85-057 TITLE: Electronic Packaging

DESCRIPTION: Approaches are needed to solve microelectronic problem areas, to model and develop new packaging approaches, reliable solder materials, optimized printed wiring boards and materials with required properties, such as specified thermal expansion coefficient and low dielectric constant. Approaches are also required in the areas of materials and process development for microwave circuits packaging. Another general area of interest associated with the manufacturing of packaging materials is the area of process control (i.e. electrochemical plating and etching).

AF85-058 TITLE: Infrared Detectors

DESCRIPTION: Air Force requirements for improved infrared surveillance capabilities dictate a need for advancements in detector materials and processing technology. Mercury cadmium telluride and extrinsic silicon materials have a high potential for meeting anticipated detector performance requirements with the emphasis being on long wavelength detection. New concepts such as heterostructures and super lattice detectors are desired for the long term applications. Detector arrays are being driven to mosaic formats of 10 to the third to 10 to the sixth elements which places increased emphasis on needs for material uniformity, reproducibility, and low cost processing. New techniques such as molecular beam and vapor phase epitaxial growth are currently being evaluated for meeting these requirements. New approaches to provide additional benefits in low cost processing and detector performance are solicited.

AF85-059 TITLE: Microwave Materials

DESCRIPTION: Gallium arsenide based amplifiers and monolithic integrated circuits are finding increased use in military systems. A key for the fabrication of these microwave devices and circuits is the basic semi-insulating gallium arsenide material that is used for device substrates. Improvement is needed in several areas, including the following: the growth techniques for large, uniform crystals, the growth of low defect material, and the identification and optimization of appropriate evaluation techniques for both bulk material and wafers, the latter area includes the need for an identification of the material and wafer properties that have the greatest effects on device performance. Device and process modeling for microwave devices will aid in this identification. In addition, improved techniques for wafer preparation are needed.

AF85-060 TITLE: Artificial Intelligence in Manufacturing

DESCRIPTION: Recent advances in artificial intelligence (AI), particularly in expert systems, have resulted in capabilities to substitute machine intelligence for human decision making. In the manufacturing arena, there are numerous situations where an accessible, easy to use, and fast computer based expert system can provide substantial economic and other benefits. Of particular interest is the application of AI to the planning, scheduling and control functions of manufacturing. Additionally, applications of AI to in-process quality assurance are of interest. Systems that would be generic and adaptable to a wide range of manufacturers, particularly second and third tier subcontractors, are of most interest. Development of approaches and techniques to create expert systems for manufacturing will be based upon a thorough knowledge of the needs and capabilities of second and third tier subcontractors. Examples of possible development areas are job shops scheduling, process planning, etc. Tradition computer programming techniques are not of primary interest.

AF85-061 TITLE: Aircraft/Missile Power Technologies

DESCRIPTION: Development of one or more of the following technologies is needed in the area of aircraft and missile power systems:

a. High temperature power semiconductor device with a maximum junction temperature of 300 degrees C, low power dissipation, and the ability to switch 10 amps at 2.5 KW per device.

b. Advanced electrochemical power source concepts are sought that offer revolutionary improvements in energy and/or power density. Batteries are needed with the following performance characteristics:
    1. Rechargeable batteries that provide a gravimetric energy density of 100 watthours/pound, volumetric energy density of 8 watthours/cubic inch, power density of 300 watts/pound, 15 year life, 1,000 charge/discharge cycles, energy efficiency of at least 80 percent, and a self-discharge rate of 10,000 hours or slower. The size range of interest is from 2 through 5,000 amperehours.
    2. Active primary batteries for survival avionics that deliver 30 or more watthours/cubic inch and at least 100 watthours/pound at the 10-hour discharge rate with pulses at the 20-minute rate near end of life. The batteries must operate over the temperature range from –65 to +210 degrees Fahrenheit.
    3. Active primary batteries for ground and mobile power applications that provide over 400 watthours/pound, over 25 watthours/cubic inch, 100-hour or slower discharges, 15 years' shelf life.
    4. High power density primary reserve batteries for airborne applications that can provide peak power densities of at least 10,000 watts/pound in a pulsed mode of operation for total active lifetimes of up to 300 seconds with shelf life of 25 years and no degradation. Other parameters of interest are: activation within 1 second or less by an electrical pulse, airborne environments, operation over the temperature range from –65 to +165 degrees Fahrenheit without any external heat source, gravimetric energy of 50 or more watthours/pound, and volumetric energy density of 1 or more watthours/cubic inch.

AF85-062 TITLE: <u>High Power for Space Applications</u>

DESCRIPTION: Development of one or more of the following technologies is needed in the area of high power for space.

a. Lightweight energy storage capacitors with an energy density greater than 500 joules per pound per assembled device, output voltage greater than 10 kilovolts, response time less than 10 nanoseconds, and lifetimes of greater than 1.0 million pulses per device. Lightweight energy storage inductors with an energy density greater than 1000 joules per pound per assembled device, output voltage greater than 200 volts, response time less than 1.0 microseconds, and an indefinitely long lifetime.
b. Repetitive opening and closing switches for pulse power output of between 10 and 100 kilovolts and 0.1 to 2.0 million amps. Response time must be less than or equal to 100 nanoseconds and lifetime must exceed one million events.
c. High power, high voltage, high current density pulse conductors that are lightweight, high-strength, and applicable for the space environment. Pure metal conductors must be suitable for use in generator windings and magnets and able to transmit pulsed as well as continuous high power without conductor failure. Intercalated graphite conductors must be lighter weight and higher strength than copper and aluminum. Also, assembled intercalated graphite conductors must demonstrate thermal stability and improved order in the graphite filaments; must be able to transmit pulsed as well as continuous high power without conductor failure. Superconducting conductors must be able to continuously carry 150 kiloamps per square centimeter at an operating temperature above 7.0 degrees Kelvin without going normal. Dielectric insulation for these conductors must be lightweight, thermally and chemically stable for the space environment and have a voltage withstand of 20 kilovolts per mil of thickness.

AF85-063 TITLE: <u>Advanced Optical Diagnostics</u>

DESCRIPTION: In-situ temperature measurements of rapidly changing or rapidly moving hot surfaces such as laser irradiated targets, laser nozzles or turbine blades are of immediate Air Force interest. These situations frequently involve the surface in contact with a mixture of higher temperature flowing gases. The advent of lasers, sensitive detectors and fast micro processing open opportunities to devise and demonstrate new fast methods of surface temperature measurement.

Some of the potential methods are fast infrared array measurements; laser induced fluorescence, and surface reflectivity. The laser-induced fluorescence appears attractive in that it might be used under the conditions of most

interest i.e., a hostile environment of hot gases. It is known that the laser-induced fluorescence spectra of some species show measurable dependencies on the matrix temperature. These dependencies usually are in the relative intensities of fluorescing bands. Techniques are sought to use this or a competitive method to perform rapid in-situ surface temperature measurements. Schemes such as ion-implementation may be considered providing the structural integrity of the blade or surface is not degraded.

It is mandatory that the method to be investigated has the potential of 5% relative accuracy, good lifetime under the operational conditions envisaged, ease of implementation and reasonable cost. Basic demonstration of the chosen method is required under laboratory conditions.

AF85-064 TITLE: Fuels Combustion Modeling

DESCRIPTION: Existing fuel combustion models, such as the Teaching Elliptic Asixymetric Characteristics Heuristically (TEACH) Code are inadequate in many respects. These models ignore the mixing that results from large scale structures. They also lack suitable chemical kinetics equations for the pyrolysis and oxidation of hydrocarbon fuels. New mixing and kinetics sub models are needed that can be incorporated into TEACH and similar codes to improve their accuracies and to account for differences in the chemical composition of fuels. Unsteady-flow codes, based on solution of the Navier-Stokes equations, are also of interest, as these codes promise greater accuracies and the predictions of the unsteady flows and instabilities found in actual combustors.

AF85-065 TITLE: Turbine Engine Test Instrumentation Techniques

DESCRIPTION: An area of ever increasing concern in the turbine engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test programs are limited by the problems associated with current structural instrumentation capabilities. The state of the art structural instrumentation has many shortcomings in both the strain gage and thermocouple areas.

Current turbine engine tests are particularly impaired by the fact that present instrumentation is, commonly, temperature limited, short lived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor.

For these reasons new sensors/systems capable of surviving the harsh environments of a turbine engine while providing accurate strain and/or metal temperature data are required. Candidate sensors/systems should be capable of withstanding temperatures in excess of 1500° for at least 50 hours of engine test while detecting strain with at least 5% accuracy and/or temperature with at least 1% accuracy. Additionally proposed techniques should have minimal influence of blade parameters and gas flow path.

AF85-066 TITLE: Fiber Weaving for Composite Components

DESCRIPTION: Fiber reinforced composite materials offer the turbine engine designer an opportunity to design lightweight, low cost, high performance engines. It is critical to such efforts that inexpensive fiber forms be available. Such fiber forms may be woven mats of dry fiber or woven forms in the shape of the component. Those and other fiber forms can be useful in fabricating the components if the structural requirements of the component can be satisfied. The desired fiber weaving effort will address potential cost savings of the fiber weaving process compared to current fiber forms; the advantages of the fiber weaving process with regard to reducing fabrication costs and improving the structural design of the component; increased capability for the particular matrix material; and limitations with existing processes for the particular matrix material; and limitations imposed by the fiber on the weaving process. The fiber weaving process may address compatibility with more than one matrix material, or multiple weaving process/matrix material combinations may be investigated.

AF85-067 TITLE: Advanced Ramjet Propulsion Systems Development

DESCRIPTION: The objective of this research is to conduct analytical and experimental studies of the fluid dynamics, chemical kinetics, and combustion dynamics relevant to the development of advanced ramjet propulsion systems. These propulsion systems include the solid fuel ramjet and ducted rocket for strategic and tactical missiles. Technology areas of particular interest include efficient combustion of high energy metallized fuels, throttling techniques applicable to water tunnel and bare wall combustion tests. Unique ideas and approaches will be screened analytically. Promising approaches which survive the screening will then transition to experimental investigations.

AF85-068 TITLE: Space Power Systems

DESCRIPTION: Military satellite power systems at present utilize silicon solar cell arrays, battery or fuel cell energy storage and power distribution, and conditioning in the 28 volt range and at .5 to 5 kW power levels. Future power system requirements are anticipated to be in the 10 to 60 kW range in the near term with peak requirements up to a factor of 10 or greater. Far term power requirements are anticipated to be in the peak megawatts range. Survivability and long life are required for all future missions. Technology needed to meet these requirements includes system and component technology in the 200 to 300 VDC range and all that implies in terms of interacting with the space environment and threats in all orbits. Enabling technology is needed to improve system performance, reduce weight and cost, and increase life to a minimum of 10 years. This may include lighter weight, more efficient solar cells, higher temperature capability through elimination of soldered interconnects, and adhesively bonded cell covers; better means to survive weapon threats; and minimizing the adverse interactions of the solar array with the space and environment in all orbits from low orbit to geosynchronous. Fully packaged rechargeable satellite batteries are needed with the following characteristics: a. a useable specific energy of 100 watt hours per pound under the following conditions: charge/discharge cycle life of up to 15,000 cycles, calendar life of 10 years or more, charge times of 5.25 to 22.8 hours, discharge times of .75 to 1.2 hours, and peak power capability of 1 kW per pound and b. a usable specific energy of 50 watt hours per pound under the following conditions: charge/discharge cycle life of 30,000 cycles, calendar life of 5 years or more, charge time of 1 hour, discharge time of 30 minutes, and peak power capability of 1 kW per pound. With respect to thermal systems, research in high power spacecraft thermal management is required in the areas of unsteady two-page heat transfer for application to power electronic cooling. Research proposals should address flow stability and heat transfer phenomenology related to zero-gravity two phase, unsteady heat exchange processes.

AF85-069 TITLE: Traction Modeling of Military Lubricants

DESCRIPTION: A program is suggested to develop a model that can predict the traction behavior of MIL-L-7808 lubricants used in rolling element bearing analysis. A large data base of traction profiles (traction coefficient vs. slide/roll ratio) has been developed on a number of military lubricants using a two-disc type tester operating at various loads, temperatures, and rolling speeds. This program would use the data base to develop a reliable traction model to be used in bearing programs such as Dynamics of Rolling Element Bearings (DREB) and Tribo 1.

AF85-070 TITLE: Turbine Engine Lubricant Screening Tests

DESCRIPTION: The lubrication of most aircraft engines relies on the use of stable ester-based fluids. Adequate test methods are available to determine the lubricant condition during use. However, additional development effort is needed to provide enhanced laboratory evaluation procedures and improved models of in-service degradation for the assessment of experimental lubricants.

AF85-071 TITLE: Logistics R&D: Space Defense Material Sources

DESCRIPTION: Support of a space based defensive system may require the processing and fabrication of material to build the space-based components. Conceptual research is needed to determine the source or combination of sources of material. Current budgetary estimates indicate conventional, terrestrial sources would be prohibitively

expensive. Some earlier studies suggest that lunar or asteroidal material may be useable. Concepts of ways to meet material requirements for a space-based defense against ballistic missiles should be developed in the research.

AF85-072 TITLE: Chemical Warfare Defensive Equipment

DESCRIPTION: The USAF has a continuing need for advanced concepts and equipment concerned with personal protection of aircrew and ground crew against exposure to chemical warfare agents. There is a need for fieldable technologies for point detection and measurement of chemical agent vapors in air. Specific needs include (1) sensitive and selective reagent systems for colorimetric, fluorescent, chemiluminescent and other chemical enzymatic techniques for measuring nerve and blister agents, and (2) reagent packaging systems such as agent-active chemically impregnated film and tapes, coating on fiber optics, etc., on which to base development of electro-optical monitoring devices and industrial hygiene type dosimeters. General needs are for small, highly sensitive detection devices for aircraft cockpit applications, and an indicator to warn that CW-agent filter projection is about to end. There is a need for a chemical agent filter for complete removal of CW-agent vapor and aerosol from breathing gases. The filter must be small and lightweight to be worn by aircrew and ground crew, must have universal capability to stop passage of all known types of agents, and must show reduced breathing resistance over current generation breathing filters. There is a need for development of improved chemical agent decontaminants for personnel. Various decontaminant sprays, powders, etc., cause harmful effects when employed directly on skin and clothing. This research would lead to effective decontaminants for nerve, blood and blister agents which have no harmful side effects when used on skin or on permeable clothing.

Examine and develop chemical compounds for applicability in don/doff experimentation. The ideal stimulant would have the same physical characteristics as any one of the chemical warfare agents. The characteristics of concern are disseminability (viscosity), off gassing (volatility), and the ability to be mechanically transferred and decontaminated (surface tension and chemical activity). In addition, the compound should be detectable in small quantities by standard chemistry practices, and should not be interfered with by commonly occurring environmental conditions. In addition, the stimulant should be virtually nontoxic to human skin and eye respiratory systems. Alternate projects in this area should examine detection methods for simulants currently in use.

AF85-073 TITLE: Enhancement of Operational Aircrew Capability

DESCRIPTION: The USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development yielding products which will enhance the capability of operational aircrew. The major areas of interest are: 1. unique selection techniques which will identify the top 20% of the operational air crew pool; 2. unique training techniques which will train those superior operational aircrew men to the point where each is a 99^{th} percentile pilot; and 3. unique approaches to the pilot-aircraft interface, with particular reference to closer coupling of man and machine, and with a stronger biological basis for the design of that interface.

The USAFSSAM interests at this announcement are global. Research proposals can address sensory mechanisms/enhancement, motor mechanisms/enhancement, and cognitive mechanisms/enhancement. Disciplines from which proposals are invited include sensory and psychomotor psychology, human performance and/or human engineering psychology, neurophysiology, psychophysiology, neurochemistry, physics, engineering, computer sciences, and the health sciences.

AF85-074 TITLE: Optical Signature Simulation/Optical Pen Aid Effectiveness Codes

DESCRIPTION: The optical signature code (OSC) used by BMO/SYMP provides detailed information and predictions pertaining to the optical signatures of reentry vehicles (RV) and penetration aids in the exo-atmospheric regime. In order to further enhance the usefulness of the OSC, a generalized scenario of critical inputs to the code is required. These inputs consist of penetration aid/RV mix and deployment conditions, most probable trajectory definition, and environmental conditions definition. The scenarios defined would represent actual targeting conditions as opposed to flight test conditions, and would be used in effectiveness assessments of optical penetration aids. The research chosen would develop the actual input scenarios to the OSC.

AF85-075 TITLE: Implication of Open Data Releases on Strategic ICBM Systems

DESCRIPTION: An understanding of the value to an opposing intelligence service of the data released through open sources and test shots into Kwajalein is required. The value to the US of revealing or denying such data must also be around. Based upon the values as defined a prioritized list must be developed for the specific data elements which should be held closely.

AF85-076 TITLE: Active and Passive Electronic Modification of Ballistic and Manuevering Reentry Vehicle Signatures

DESCRIPTION: Innovative active and passive techniques for the modification of reentry vehicle signatures (body and wake) shall be addressed. The study can include application of these techniques on both ballistic and maneuvering reentry vehicles. Theoretical approaches will be pursued to select promising concepts that may be able to avoid enemy defenses through electronic deception techniques. Studies will address theory behind approaches, packaging, power requirements and preliminary effectiveness analyses.

AF85-077 TITLE: Study of Anti-Simulation Techniques Applicable to Ballistic and Maneuvering Reentry Vehicles and Associated Penetration Aids

DESCRIPTION: Study should include analyses of ballistic and maneuvering reentry vehicles and associated penetration aids incorporating anti-simulation techniques. Analyses should identify those observables which may best be modified by these techniques and the applicable range of observables required to increase the penetration effectiveness of the reentry vehicles.

Effectiveness analyses must be incorporated against realistic threats. Innovative approaches to anti-simulation techniques will be explored.

AF85-078 TITLE: Wake Modification of Ballistic and Manuevering Reentry Vehicles and Associated Penetration Aids

DESCRIPTION: Innovative techniques for suppression of reentry vehicle wakes and/or the enhancement of the associated penetration-aids wakes should be examined to address basic chemistry issues of possible quenchants and/or enhancers and their application. The injection and/or mixing of these materials into the wake must be addressed to optimize their effectiveness. Techniques sought could include active and/or passive methods of introducing quenchants and/or enhancers to the wake.

AF85-079 TITLE: Optical Masking by Means of Expulsion of Materials

DESCRIPTION: An in-depth analysis of an optical masking technique which employs expelled materials is desired. The analysis should concentrate on development, verification and extension of computer models based on available flight test data. Limited ground testing may be required.

AF85-080 TITLE: Optical Sensor Inhibition Techniques for Ballistic Missile Defense Systems

DESCRIPTION: Innovative techniques for the suppression or inhibition wideband of BMD optical sensors are required active, passive (including RV and penetration aid OCM coatings), and tactical methods should be exploited.

AF85-081 TITLE: Effects of Noise on Discrimination of Decoys

DESCRIPTION: A study is required to evaluate the degradation of a defensive radar's ability to discriminate decoys from reentry vehicles when an under-populated cloud of jammers provides a noise field between the radar and the hard objects. Provide a model for estimating equivalent K-factor as function of signal to noise. Consider alternate means for improved threshold selection in this scenario and compare the resulting PL, PFA statistics.

AF85-082 TITLE: Active Chaff

DESCRIPTION: Chaff has proven to be an effective exatmospheric penetration aid for ICBM applications. A primary problem with chaff is a slow-down in velocity as the chaff reaches denser atmosphere. This slow-down allow radars to "see into the chaff" and detect RVs which are moving at a higher relective velocity to the chaff elements. The application of elements which return radar energy in the required Doppler spectrum could make the chaff effectiveness independent of its real velocity.

A study is needed to perform the following tasks: 1. Determine the minimum size and weight of a half wave length dipole (frequency to be determined) which has a "make-break" electrical connection at its midpoint. The "make-break" frequency (Doppler spectrum) is controlled by a random rate multivibrator. 2. Determine the amount of power required to operate this device as a function of time with a 10% duty cycle over an elapsed time of 30 seconds to 30 minutes. 3. Determine the change in size and weight to add the stored power (as a function of time) to the chaff element. 4. Determine the feasibility of acquiring the operating power from the incident radar energy.

AF85-083 TITLE: Radar Suppression Techniques for Ballistic Missile Defense Systems Sensors

DESCRIPTION: Innovative techniques for the suppression of BMD radar sensors are required to enhance expected penetration and kill probabilities of US reentry systems. Techniques sought could include active, passive, and tactical methods. An example would be a vehicle which generates EMP near to and directed at the radar. The contractor should evaluate vehicle weights or weight impacts (mods to existing vehicles), damage mechanisms, and technology limits.

Recommend technology for technology-limited aspects of the system design.

AF85-084 TITLE: Optimum Navigation

DESCRIPTION: The introduction of "Smart" RVs suggests an ability to counter effectively a wide variety of targets under extreme operating conditions with warheads of dramatically reduced yield. This new class of RVs is expected to be equipped with a terminal homing capability and will require new navigational laws. It is further suggested that optimal energy management could result in significantly reduced control weights/volumes and, thereby, potentially offset similar increases required for the RVs intelligence.

AF85-085 TITLE: Ring Laser Gyro (RLG)

DESCRIPTION: An area which needs development effort is the RLG operation in a nuclear environment. The RLG differs from spinning mass gyros in that it has no memory to allow recovery in the nuclear environment. This study should investigate the technology effort required in the area of circumvention, recovery and hardening of the RLG.

AF85-086 TITLE: Small Lightweight Hardened Guidance Computer/Component

DESCRIPTION: The Peacekeeper computer was designed for production using current (1983) radiation-tolerant semi-conductor components resulting in a heavy, relatively large and high power consumption assembly. As a result the Peacekeeper will not satisfy advanced booster requirements. This study should investigate the feasibility

of developing a small lightweight radiation hardened low power computer for missile navigation guidance and control.

AF85-087 TITLE: Hemispherical Resonator Gyro (HRG)

DESCRIPTION: This task will evaluate the accuracy levels for quick reaction gyro compassing in ballistic missile application. Accuracy, error sources and nuclear hardness must be characterized.

AF85-088 TITLE: Economical Geotechnical Exploration Concepts

DESCRIPTION: The ability to economically determine geologic properties is important to the Deep Basing Program. Geologic properties data, for some regions of interest, does not exist. Development of a system or systems to quickly and inexpensively measure in-situ material properties down to depths of several thousand feet and to "see" significant distances ahead of a tunnel alignment is needed. These measurements are currently best obtained through vertical and horizontal drilling and are thus very expensive. Material characteristics of interest include rock strength, stiffness, fracturing, and deformation properties. These characteristics may be measured conditions. The degree of precision needed will vary depending on the property and the geologic screening process involved. Thus, the cost and time required to acquire data versus the protection of measurement of the data will be an important consideration.

AF85-089 TITLE: Tunnel Closure Concepts

DESCRIPTION: A deep based missile complex will require closure to seal portions of the complex to provide physical security of critical assets, separate environmentally controlled areas from non-controlled areas, provide blast protection, and close off active egress paths. This research could identify innovative closure concepts capable of quick opening/closing capability, providing clear tunnel cross section when open, hardening to nuclear weapons effects, minimize cost, and high reliability. Development of a workable closure concept is essential to survivability of a deep base.

AF85-090 TITLE: High Altitude Synthetic Aperture Radar (SAR) Operations

DESCRIPTION: The use of SAR to support ballistic missile application requires the parametric development of envelop/boundaries for trajectory, altitude and pointing, velocity, and SAR foot-prints. Additionally target-signature/sensor-matching methodologies need to be developed to accommodate signature type, propagation phenomenology, discrimination input factors, and multisensor utility. Lastly, on board equipment needs to be addressed in terms of sizing, on board processing, C3 and fusing.

AF85-091 TITLE: Search Algorithm for "Intelligent" Reentry Vehicles

DESCRIPTION: "Intelligent" RVs have the capability to search large intercept volumes for a target and then track/guide to the target. At a higher level of sophistication, the RV could conceivably classify individual targets within an intercept volume, order the targets according to come priority. The impact of this operational mode on the sensor search algorithm and the interaction with, and handover to, the track mode/algorithm needs to be definitive and the consequent impact on sensor design determined. Dedicating the search/target assignment function to an intelligent bus is of particular interest.

AF85-092 TITLE: Three-Color Optical Pyrometry Temperature Measurements

DESCRIPTION: Temperature measurements of reentry vehicle materials in ballistic range ground testing have been plagued with uncertainties in emissitvities, difficulties in looking through boundary layers, and inadequate

resolution. The objective is to provide a reliable measurement of true temperature through the use of three-color optical pyrometry. The pyrometry system should be capable of measuring temperatures from 800-6000°K with response times of 2-10 nanoseconds. The spatial resolution should be less than 0.1 in over an area of approximately 1.5 inches squared (reductions in area coverage are acceptable). The study should include development of data reduction algorithms to provide temperature maps of the test article to the analyst.

AF85-093 TITLE: Low Altitude Dispersal Techniques

DESCRIPTION: There has developed a need to disperse up to 1000 small objects of approximately 10 lb. total weight from a small reentry vehicle at low altitudes. A study is needed to define various feasible concepts such as explosively expelling the objects from the base region of the vehicle. The study must address the aero thermodynamic implications of different techniques on vehicle design and electronic packaging of the vehicle and its payload section.

AF85-094 TITLE: Near Field Effects of Microjammers on the ABM Radars (WEEDS)

DESCRIPTION: Defense suppression penetration aid devices that use radar homing guidance to place the device near or at the radar may be susceptible to countermeasures. The following study is required: Using projected defensive system threat definitions, evaluate degradation of radar performance when various numbers of small low-power jammers continue operating after falling to the ground very near the radar. Provide power-distance-noise relationships including the effects of local terrain and clutter fences of various heights and distances from the radar.

AF85-095 TITLE: Localization of Ground Mobile Targets

DESCRIPTION: Advanced ICBM designs exploit the concept of mobile basing. An effective offense against such relocatable targets is closely coupled to the ability to identify and localize them on a continuing basis. Sensors are available which can detect mobile missiles which are either a. in the open or b. accessible to viewing at shallow angles (e.g. sitting along free lines). Current sensing techniques cannot detect targets under foliage or in weather. The objectives of the program include: 1. development of a fundamental understanding mobile targets signature issues; 2. identification of techniques for distinguishing postulated signatures from surrounding such techniques and; 4. evaluation of countermeasure potential. Such a solution should address technical and programmatic issues as well as being acceptable under current treaty restraints.

AF85-096 TITLE: Design for RV Antenna Window Interaction and Plasma Attenuation Experiments

DESCRIPTION: The objective of this research is to design innovative ground test experiments to assess RV antenna window thermal and ablation response, and signal attenuation through the shock layer and boundary layer. These experiments shall utilize existing ground test facilities such as arc plasma jets, rocket exhaust facilities, or ballistics ranges. The ground test design should be based on careful quantitative analysis of the appropriate similitude requirements, flight conditions, and available ground test conditions. In the case of antenna window testing, attention should be focused on simulating quantities affecting interaction of the window material with adjacent heat shield materials. Non-similar boundary layer effects and other sources of ablation contour irregularities should be evaluated. For the plasma attenuation test design, the electron concentration profile, collision frequency, and shock and boundary layer thicknesses for flight conditions should be evaluated. If it is not possible to simulate these, simulation of appropriate products should be assessed. Owing to the difference between flight and available ground test conditions, it is anticipated that the ground test fixtures may look substantially different from flight hardware, and that highly innovative test model designs and instrumentation will be required.

AF85-097 TITLE: Transpiration Cooled Nosteip Flow Calibration

DESCRIPTION: The transpiration cooled nosetip (TCNT) is an actively cooled nosetip which ejects a liquid coolant through hundreds of small ports distributed uniformly over the face of the nosetip. These tips have a small radius (0.3 in) in either a hemispherical or flat-face configuration. Calibration measurements of the coolant flow need to be made over annular and circumferential sections of the tip. Details of typical geometries and coolant flow rates (with measurement accuracy goals) will be provided by the BMO to interested contractors.

AF85-098 TITLE: Flexible Radiation Shields

DESCRIPTION: Future decoys for Maneuvering Reentry Vehicles (MaRV) will be made inflatable so that they can be stored compactly and then expanded to full size upon deployment. These inflatable structures will require a flexible external shield (overlay) for protection from hostile encounters. For decoy credibility it may be desirable to use the same flexible overlay on the MaRV, although current MaRV overlay designs are a rigidized material.

The flexible overlay material will be subjected to bending during packaging and storage and to stretching during inflation, normal flight, and hostile encounter. The response during hostile encounter will include large deflections and shape changes. Currently available flexible overlay materials have been fabricated and tested in small quantities using available materials originally developed as reinforcements for rigidized overlays.

The decoy and MaRV designs should be reviewed to identify material requirements, including such qualities as strength, stiffness, X-ray cross section, thermal and electrical conductivity, crease-resistance, etc.

AF85-099 TITLE: Hypervelocity Ground Test for ITP Program

DESCRIPTION: The ITP Program needs to develop a method of full scale ground testing for the ITP reentry vehicle. Since this requires speeds in excess of 10,000 ft per second, it is beyond the state of present technology. The proposals should address ways to achieve the velocities required for ITP, while staying in the realm of ground test costs. This is needed to confirm total reentry vehicle full scale performance before ballistic flight test.

AF85-100 TITLE: Laser Damage to RV Antenna Windows

DESCRIPTION: In general, reentry vehicles have a high laser hardness because of their design for high heat fluxes, reentry aerodynamic loads, and nuclear encounters. However, antenna windows may be particularly susceptible to laser attack because of the high transparency of typical window materials for some of the laser wave lengths of interest. This will allow the laser energy to reach antenna components which are not normally exposed to high temperatures. This suggests that a program to investigate the laser vulnerability of antenna windows is required.

The objective of this study is to determine the hardness of typical RV antenna windows and components to laser exposure, including both continuous wave and pulsed lasers, and to identify hardening techniques if needed. Typical antenna window designs should be evaluated for laser hardness using analysis and the existing data base. If material data, such a transparency, does not exist for the materials at laser wave lengths of interest, it should be generated.

AF85-101 TITLE: Exploitation of Tactical Warfare Technology for Strategic Warfare

DESCRIPTION: A broad range of technologies have been developed for advanced tactical weaponry. It could prove quite valuable to explore the application of these technologies to ballistic missile warfare, e.g., non-nuclear weaponry, special radars for detecting armored vehicles. The technology should take a ballistic delivery system as the baseline and then expand on the system.

AF85-102 TITLE: Target Assessment Damage by Ballistically Delivered Sensors

DESCRIPTION: Accurate damage assessment is critical for targeting second wave launches. Properly delivered sensors can provide needed information for this purpose. One method worth exploring is the use of an RV to dispense sensors in the target area after the remaining RV's have penetrated.

AF85-103 TITLE: Ablative Material Surface Roughness Characterization

DESCRIPTION: The surface roughness of ablative nose tip and heat shield materials has a substantial effect on boundary layer transition, and heat, mass and momentum transfer. A fundamental understanding of ablative material surface roughness development, leading to an a-priori prediction capability for the size and shape of the roughness elements, is needed. This may be derived from simple experiments which isolate causative effects and/or analysis of available data and the physical processes involved. For conditions where some form of blowing and/or transpiration is present (e.g., ablation or active cooling), the transpiring materials are subject to turbulent diffusion amongst the elements constituting the surface roughness. The phenomena associated with the roughness and the transpiration then interact to dictate the convective environment. In certain instances (e.g., the missile reentry environment), the gasdynamic certain instances (e.g., the missile reentry environment), the gasdynamic boundary layers are very thing so that protuberances in the micron size range and larger can provide significant convective augmentation. The levels of augmentation influence system drag and dictate the amounts of thermal protection material (ablative material or transpirant) required. It is difficult to create representative boundary layers in ground test that can be sufficiently instrumented to quantify the effects of surface roughness. Therefore, a need exists for establishing an analytical technique for incorporating these effects into a methodology that can be applied with a high level of certainty to the real flight environment.

AF85-104 TITLE: Active Cooling Mechanisms for Reentry Vehicles

DESCRIPTION: A number of techniques exist for actively cooling intensely heated surfaces. However, in the missile reentry environment, it is extremely difficult if not impossible to instrument with sufficient detail to quantify the significance of the controlling cooling mechanisms. In certain instances, the cooling mechanisms themselves are dictated by the environment to which the surface is exposed (e.g., pressure and temperature effects on condensed phase materials). Certain emerging missions may be possible only through application of active cooling schemes. Thus, it is important to understand the cooling mechanisms and be able to quantify them in order to design an advance system that will survive the environment to which it is exposed. Available cooling techniques need to be reviewed, existing data need to be critically evaluated, and critical experiments defined that will provide data that may be incorporated into analytic models to quantify the utility of the cooling techniques.

AF85-105 TITLE: Management of Ground Water Flow for Deep Underground Tunnels

DESCRIPTION: Water management is a major consideration in underground operation. A deep based system may be located in a geologic formation below the existing water table. Should this condition exist, water management methods must be employed during construction, peacetime operation, and under post attack, buttoned up conditions. Water management may involve sealing water from the deep base or disposing of it after it enters. Since the deep based system must continue to operate after a nuclear attack, techniques for water management during system operation must be as survivable as the system itself. The objective of this effort is to define the feasibility of water management concepts and to develop reliable methods to alleviate sudden inflow due to ruptured liners after a nuclear attack. These data should allow determination of the amount of ground water that can reasonably be accommodated for use in defining geologic screening criteria. Methods should incorporate innovative handling of simultaneous breaks with a minimum dependence on crew availability.

AF85-106 TITLE: Explosive Excavation Methods

DESCRIPTION: The conventional excavation method for driving drifts and tunnels in hard rock conditions utilizes some form of explosives. This method offers considerable flexibility in meeting the challenges of geologic, geometric, and other excavation requirements, but because of its cyclic nature (drill, load, blast, muck), it suffers in advanced rate and is generally inhibited from any significant improvements. Inevitably, this method is compared – usually with unfavorable results – to highly mechanized tunnel boring machines TMB. Further consideration of explosive excavation techniques should be encouraged because, unlike the TBM, explosives are not very sensitive to variations in rock hardness, often provide the most efficient concentration of energy into rock fracturing, and are not restricted in excavating variations in tunnel geometrics. Post attack eliminate the need for large power cables and hydraulic lines to operate sinks, eliminate the need for large power cables and hydraulic lines to operate TBMs, and increase the potential to excavate structurally disrupted bedrock. Several study efforts to devise explosive excavation methods have been accomplished in the past, but currently there is little or no activity in advancing these studies. Innovative approaches to improving explosive excavation techniques could improve the viability of a deep base.

AF85-107 TITLE: Impact of Directed Energy Weapon (DEW) Deployment on Penetration Aids

DESCRIPTION: Examine the implications of DEW threats of penetration aid effectiveness. The study should include passive and active decoys, chaff, and the defense suppression vehicle. Survivability and reduction in mission effectiveness will be addressed. The threats, gross vehicle characteristics (size, external material, and first order functional description), and chaff deployment parameters will be provided by the BMO. Potential means of reducing vulnerabilities (to include denying acquisition, pointing, and tracting) should also be identified.

AF85-108 TITLE: Laser Hardening External Protection Material (EPM)

DESCRIPTION: In the 1990 to 2000 time period there is a possibility that a high energy laser (HEL) may be developed which could be used to intercept US ICBMs during boost phase unless appropriate countermeasures are taken. One such countermeasure is the addition of EPM which would provide laser hardening in addition to its nuclear weapons effect role. The objective of this activity is to investigate hardening countermeasures to space or ground based HELs.

AF85-109 TITLE: Directed Energy Weapons Effects Phenomenology

DESCRIPTION: The phenomenology behind materials and electronics interactions with certain threat size class directed energy radiation fluences is not fully understood. As a result, the effects of directed weapons threats on present and future intercontinental ballistic missiles and other systems cannot be accurately predicted, so that possible failure modes and overall system survivability cannot be properly assessed. A study is required to provide a first order determination of this phenomenology. Study results will be used in the determination of test requirements.

AF85-110 TITLE: Heatshield Performance Evaluation

DESCRIPTION: Reentry vehicle heatshields limit thermal penetration through the combined effects of ablation and the insulative properties of the heatshield material. Ablation performance is dictated in part by the surface roughness characteristics in response to the adjacent aerothermal environment. A wide variety of discipline is involved in the design of a heatshield, prediction of its performance, and evaluation of its behavior in flight. The end effect of a shortfall in any of these areas is the apparent need for excessive heatshield materials to account for design contingencies. In order to reduce the current design margins so as to achieve higher payloads, it is essential that available data be brought together and assessed in light of the predictive techniques that are being employed to design the heathsields. The need is to assemble and critically evaluate the broad range of existing data, document

the results of the survey and analysis for use by the technical community, and provide a rationale for and procedure that leads to the reduction of design margins.

AF85-111 TITLE: Hardened Composites for Space Vehicles

DESCRIPTION: Advanced composites such as graphite epoxy and Kevlar epoxy have exceptionally high strength-weight and stiffness-weight ratios in the direction of the fiber reinforcements. However, their transverse properties, which depend primarily upon the stiffness, strength, and fracture toughness of the matrix material, are not as good. Current matrix materials such as epoxy, polyimide, and phenolic tend to be relatively brittle. Materials with greatly improved toughness, such as polybenzimidazoles, have been under development. These materials have now been fabricated in sufficient quantities to permit property measurements and assessment of their potential for reentry vehicle and booster application for weight saving and hardness improvement.

The objective of this study is to review the properties of advanced resins and identify those offering the greatest improvements in weight and performance. A review of new resins being developed in Government and other laboratories should be made to identify those which are sufficiently developed to warrant various reinforcements for typical booster and RV applications to determine their potential for weight saving and improved hardness. The better materials should be identified.

AF85-112 TITLE: Hardened, Lightweight Aft Cover Design

DESCRIPTION: Present designs of aft covers of reentry vehicles may not be suitable for higher levels of exposure, which are anticipated in the future. A study is needed which will define those parameters which are crucial to the design of RV aft covers at higher levels of exposure. The study should also evaluate advanced materials such as metal matrix composites, super plastic alloys, and hybrid composites for RV suitability.

Possible parameters to be investigated are 1. material characteristics, such as stiffness, ductility, and fracture toughness, 2. geometry parameters, such as shape, thickness and discontinuities, and 3. response mechanisms, impulsive or thermo structural response.

The study should identify aft cover designs incorporating materials and design features offering increased hardness against nuclear effects at lighter weight. The study should also identify design requirements such as hostile exposure, reentry loading, penetrations, and attachments. Possible design configurations, including those with advanced heatshield and substructure materials, should be postulated and evaluated to determine which parameters are most important. Attractive design approaches should be identified.

AF85-113 TITLE: Resolution Requirements for Strategic Targets

DESCRIPTION: In support of Ballistic Missile Office activities related to “intelligent” ballistic missile systems, a description of strategic targets in terms of resolution required for detection, identification, classification, recognition, etc. is required. These data, when combined parametrically with the time line associated with typical employment scenarios, could provide both processor size and processing speed requirements. Coupled with assessments of current (and projected technology,) feasibility/viability of proposed hardware concepts could be assessed.

AF85-114 TITLE: Fast Launch ICBM Technology Requirements

DESCRIPTION: Studies are underway to determine the conceptual feasibility of ICBM’s using fast launch and/or short boost time tactics to achieve basing survivability and to inhibit boost and midcourse phase targeting activities from adversary nation space surveillance systems. This study will help determine technology requirements relevant to fast launch/short boost time concepts.

AF85-115 TITLE: Fiber Optic Technology

DESCRIPTION: Examine the luminescence and absorption characteristics phenomenology for light generating, transmitting and receiving components under radiation conditions encountered in ICBM environments. Devise the technology to reduce the radiation effects on the fiber optic system by:

a. evaluating new materials
b. developing detection circuitry
c. signal transmitting
d. developing signal format that will reduce vulnerability

AF85-116 TITLE: Space Systems Vulnerabilities

DESCRIPTION: As a result of current and ongoing studies, it is apparent that space is becoming more of an important strategic arena. One aspect of this reliance on space assets is the vulnerability to direct attack or to disturbances in the intervening atmosphere. This study should consider the spectrum of vulnerabilities of space systems incorporating a variety of C3 or of space sensor type systems. Vulnerabilities include effects due to direct and indirect attack as may result from a direct assault on the space platform and/or nuclear disturbed regions in the intervening media (i.e. nuclear debris, Van Allen disturbances, upper atmosphere etc.).

AF85-117 TITLE: Survivable Gages for High-Level Blast Environments

DESCRIPTION: The gages used to measure stress on silo components during simulated nuclear explosions tend to fail at the blast overpressure levels of today's tests. New measurement tools to determine silo structure response in these extreme environments are required.

AF85-118 TITLE: Unique Signal Devices

DESCRIPTION: Unique signal devices (USDs) are used to insure the missile and warhead cannot function without receipt of a valid command code. Present devices are heavy, slow, expensive, and have hundreds of small moving parts. A reliable USD capable of passing nuclear surety criteria is needed.

AF85-119 TITLE: Investigation of Non-Nuclear Hard Silo Kill Mechanisms

DESCRIPTION: The BMO Hard Silo program is examining harden missile silos against nearby nuclear bursts. However, possible ways of disabling a silo-based missile other than nuclear weapons should also be addressed. A "Red Team" approach to this problem might be useful. Some of the possibilities for investigation would include:

-hypervelocity projectiles
-space-based lasers or neutral particle beams
-non-nuclear explosives used in conjunction with highly accurate surface or earth penetrator delivery.
-radiation-induced kills through use of enhanced radiation warheads instead of the usual blast overpressure will from thermonuclear fission-fusion-fission weapons.

The study should address the likelihood of such threats occurring during the 1990-2010 time period as well as the technical feasibility of the threat.

AF85-120 TITLE: Definition and Assessment of Physical Security Threats to Small ICBM Basing Systems

DESCRIPTION: A requirement exists to define and assess potential physical security threats to the small ICBM Hard Mobile Launcher (HML) as posed by terrorist/paramilitary groups and counter against these threats. Threat definition should characterize potential threats based on review of existing documents which summarize past

terrorist activity at home and abroad. Threat considerations should range from theft to destruction. Characteristics should include likely numbers of people per group, types and capabilities of weapons, operation, and other conditions to include day and night operations. Primary inputs to this study would include the Strategic Air Command's concept of operation for the small ICBM, the Ballistic Missile Office's threat definition Assessment Report, and summaries of terrorist activities. Based on the contractor's threat definition and assessment, methods should then be recommended to guarantee a very high level of protection against these threats at a reasonable cost. Emphasis should be on discovering new, cost0effective concepts, based on innovative application of state=of=the-art technology including shields, intrusion sensors, electronic/laser fences, operational procedures, etc.

AF85-121 TITLE: Reactive/Response Threat Intelligence Indicators

DESCRIPTION: Establish a documented data base which contains all-source evidence specifically related to reactive/responsive threats against Peacekeeper, the Small ICBM, and advanced missile basing concepts. Emphasis should be placed on hard silo and deep underground concepts. The proposed effort involves the development of data base search profiles and assessment of threat capability in selected areas of relevant applied technology and development.

AF85-122 TITLE: Composite Erosion Test and Model Development

DESCRIPTION: Establish a comprehensive thermal and erosion data base for selected reentry vehicle materials and associated independent response models. These data should be for materials postulated for use in the production of specified threat reentry vehicles. Based on an analysis of thermal properties controlled ablation tests, and erosive testing, performance of these vehicles in flight environments can be characterized to assess erosive resistance.

AF85-123 TITLE: Projection of Soviet ICBM and SLBM Accuracies

DESCRIPTION: Project Soviet ICBM and SLBM accuracies for the year 2000 and beyond based on analysis of telemetry, radar, infrared, and other available data. In particular, this analysis should assess the projected accuracies of the SS-18 Mod 4 ICBM and new ICBMs under development as weel as the SS-N-20 and advanced SLBMs. This study should be limited to ballistic trajectories with no consideration of maneuvering RVs.

AF85-124 TITLE: Assessment of Surveillance Information Cycle Time for Small Mobile Systems

DESCRIPTION: The small mobile missile system achieves survivability by denying knowledge of location of the individual missile to the enemy. The time a missile can "park" at one location or garrison depends on the time required by the significant time lag in the surveillance/targeting process. This study will project surveillance capabilities and information processing and retargeting capabilities based on technology projections for the mid-1990 to 2000 time period. Based on the projection and a description of the system and concept operations, an assessment will be made of the timelines for retargeting which could be achieved by a potential attacker in the 1990s and beyond.

AF85-125 TITLE: Effect of Cloud Cover on Surveillance of Mobile Small ICBM

DESCRIPTION: Based on historical cloud cover data for proposed Small ICBM deployment areas, determine the effect of cloud cover upon Soviet satellite based photo sensors attempting to detect and identify the various proposed Small ICBM mobile launcher systems. Study should parametrically consider the percentage of cloud cover, satellite altitude, sensor resolution capability, amount of daylight, and other factors such as dust, haze, and ground fog. Study would statistically model all proposed sites, both individually and collectively, so as to determine sensor degradation. Size and shape of the candidate launch systems will be an important consideration.

AF85-126 TITLE: Mechanical Application Technology of Ablative Barriers on Radome Substructure at Millimeter Wave Frequency Operation

DESCRIPTION: This would be a study of techniques for applying thermal ablation coatings and environmental barriers to radome structures consisting of cast silica ceramics as well as various fiber and plastics laminates. The informal and environmental protection with minimum attention of radio frequency energy at millimeter wave frequencies greater than 20 GHz.

AF85-127 TITLE: Rain Effects on Radio Frequency Propagation

DESCRIPTION: Conduct a study to determine the effects of rain on RF propagation over the frequency spectrum of UHF to EHF frequency bands. The study should characterize the spatial and temperal aspects of rain and characterize all propagation effects such as attenuation, phase, group delay, etc. Numerous studies have been previously conducted on this subject and vast amounts of data exist in this regard: however, a wide range of uncertainty exists and the communications system designer is confronted with conflicting data. Using existing rain propagation data, it is possible to show any condition from complete link outage to one of minimal or no effect. The subjectiveness of existing data does not take all studies and analyses into account and leaves the satellite communications designer with inadequate data. This study should pursue the principal objective of collecting, compiling and correlating all existing obtainable data and, using the latest analytical techniques, analyze rain effects and establish a design handbook to aid communication system design.

AF85-128 TITLE: Nuclear Scintillation on RF Propagation

DESCRIPTION: Conduct a study to determine the nuclear scintillation effects on satellite RF propagation to ground terminals in the 7-8 GHz and 20-40 GHz frequency band. The study should characterize the fade depth, fade rate, and fade duration aspects of scintillation and shall have, as a primary objective, the problem of resolving major differences between existing scintillation studies. This study will be based on Defense Nuclear Agency's (DNA) latest work/mathematical models for nuclear scintillation and shall develop system design requirements for scintillation for the RF frequency band specified herein.

AF85-129 TITLE: Remote Sensing of Meteorological Parameters

DESCRIPTION: The purpose of this effort is to develop spaceborne sensors capable of providing data on the meteorological parameters necessary to accomplish the mission of the Defense Meteorological Satellite Program (DMSP). Listed below are the meteorological parameters for which improvements over the present capability of the DMSP sensors are desired. The present DMSP capability and eventual goals are both listed. An improvement of 30-40 percent or more over present capabilities in the areas listed would be of interest.

While sensors currently in use by DMSP provide much useful data, improvement in the capability of the sensors is desired. The accuracy of data provided in DMSP is a limiting factor in operational support of DoD forces and the making of accurate and timely weather forecases. Any improvement in DMSP sensors would permit an improvement of weather forecasts.

New measurement techniques or approaches, and improvements in critical sensor components, subsystems, and proof-of-concept sensors for use on future DMSP spacecraft are desired.

AF85-130 TITLE: Optical Signal Processing Technology Survey

DESCRIPTION: The advent of gigabit-per-second digital communication signaling speed threatens to outstrip what is presently the domain of complementary metal oxide semiconductors (CMOS) and very large scale integration/very high speed integrated circuits (VLSI/VHSIC) technology. Before GaAs technology is able to extend silicon solid state technology into the gigabit speed era, electro optical digital signal processors may come of

age and may open up new areas to the field of communications signal processing, not readily accomplished otherwise. Specific areas which need investigation for applicability and development are and include:

1. Matrix signal vector and multiplication and inversion. The immediate needs and applications include signal nulling, signal demodulation by transform algebras and decoding.
2. Signal correlation and convolution, interleaving, coding, multiplexing their inverse processes, and other which may be feasible at gigabit rates.
3. Signal processing components, devices, and entire systems.

The objective of this program is to identify feasibility for space qualified service and to initiate follow-on developmental activity leading to service test hardware.

AF85-131 TITLE: Spaceborne Mass Storage Devices

DESCRIPTION: Develop a replacement for mechanical magnetic tape recorders to store large amounts of binary format data in a spaceborne environment. Storage capabilities in the order of 1.7 x 10 to the ninth bits and continuous operations of seven years with high reliability without external maintenance are required. The memory readout should be non-destructive with positive controls to prevent unauthorized alteration of memory content during all phases of operation. The solid state technology used should be hardened to 2 x 10 rads (Si) total dose as a minimum.

Increasing Mean Mission Duration (MDM) and past orbital failures have demonstrated the need for replacement of the currently used mechanical magnetic tape recorders with longer lifetime, higher reliability devices.

Space qualified mass storage devices with a capacity of 1.6 x 10 to the ninth bits is desired. Ideally, these devices should be interchangeable with magnetic tape recorders on existing space systems.

AF85-132 TITLE: Doppler Wind Sensing Lidar and Differential Absorption Lidar (DIAL) Sensors

DESCRIPTION: Spaceborne Lidar sensors have the proven potential of measuring the Doppler frequency shift of radiation backscattered by atmospheric aerosols. Spaceborne DIAL sensors have the potential of measuring temperature and moisture profiles by measuring the intensity of return of radiation emitted near 02 and water absorption lines, respectively. There is also potential for qualified measurement of visibility using Lidar sensors. The goal is to develop sensors for DMSP spacecraft capable of satisfying the validated requirements for wind, temperature, moisture and visibility.

The problem is to develop pulsed laser sources with the necessary lifetime (two to three years at 10 Hz pulse repetition rate), wavelengths, diffraction limited beam, energy (10 Joule), lightweight laser transmitter system, suitable detector system and optimum efficiency to reduce spacecraft power requirements.

Spaceborne active sensors capable of providing required wind, moisture, temperature, and pressure data are desired.

AF85-133 TITLE: Solid State Device Replacement for Photomultiplier Tubes

DESCRIPTION: The purpose of this effort is to develop a solid state device with a long lifetime (up to seven years) and performance equal or superior to photomultiplier tubes (PMT) in all other areas including cost and the ability to operate under lower illumination than the quarter moon now required of present PMTs. The solid state device will replace PMTs in the DMSP Operational Linescan System (OLS).

The photomultiplier tube currently used in the OLS is especially designed for this application. Long duration life tests have not been possible because of the small number of PMTs available for the OLS. Consequently, present reliability estimates are based on reliability experience with many PMTs not of this particular design. The technology product desired is flight-qualified long lifetime solid state device to replace PMTs in the DMSP OLS.

AF85-134 TITLE: Solid State Detector Array Technology

DESCRIPTION: The purpose of this effort is to develop a solid state detector array that operates in at least the visible (0.4 to 1.1 micrometer) and infrared (10.5 to 12.5 micrometer) special regions. The detector should be a 190-310K equivalent black body with a noise equivalent temperature difference of less than .5K with a goal of .1K. Geometric resolution should be 0.3 nmi from 450 nmi altitude over a 112 degree scan angle with a geometric location accuracy of one milliradian. Orbital lifetime should be at least three years with a goal of four years and be able to withstand the orbital environment at 450 nmi.

The current primary sensor of DMSP spacecraft consists of point detectors illuminated by an optical scanning telescope system which is driven in a sinusoidal motion by counter reacting coiled springs and a pulsed motor. A solid state detector array may significantly enhance system reliability and relax current structural and attitude control requirements. Array technology has been principally focused on optical scanning in the visible spectrum rather than a combined visible and infrared. Evolving technology should make a combined system feasible.

Laboratory hardware meeting objectives for integration into the next generation DMSP satellites is desired.

AF85-135 TITLE: Advanced Nulling Algorithms

DESCRIPTION: Nulling algorithms presently applied in adaptive nulling systems have not advanced significantly over the years. Advanced algorithms are need to give nulling antennas under design the capability to deal with the projected increase and more sophisticated threat of interference sources.

Adaptability of the nulling system is needed to accommodate and handle rapid charges in jammer and user characteristics such as frequency, waveform and location.

The advanced algorithm has to be hardware compatible. Consideration should be given to be derived identifying the hardware building blocks needed. A flow diagram of the algorithm shall be matched to the hardware diagram.

AF85-136 TITLE: A Multiple Beam Antenna (MBA) with Feed Clusters for Multiple Limited Area Coverage over Extended Field of View (EFOV)

DESCRIPTION: When limited area coverage zones can be defined which are spread over the EFOV, it is desirable to have a suitable antenna design. Often, a phased array is proposed. Design effort is needed to generate performance parameters for an MBA which provides multiple coverage areas, each only a fraction of the total EFOV.

AF85-137 TITLE: Signal Access and Synchronization Technology

DESCRIPTION: When hundreds or thousands of processing relay satellite customers/users wish to gain access channels, it is essential for high quality service that access time and full recognition and frame/bit synchronization be minimized. This means that some automated method is required for fulfilling the processes of call-up, slot reservation, message exchange, exercise of priority, authentication, ARQ, and sign-off.

Most users will operate at 2400 bits per second, while the range may be expected to include 75 bps, 9600 up to 1,344 Mbps and some at video and even at 110 Mbps. Several existing traffic studies in and out of DOD/DCA indicate clearly the mix of customers and message flow so that it is not necessary to reinvest a traffic model, but rather, it is desired that protocols and procedures be established and implemented. When this has been done, it shall be possible to develop message software structures and headers plus hardware implementation on chips such that digital message processing and routing are standardized and expressed in semiconductor-dedicated chip families.

The objective of this task is to define, characterize, and initiate development of signal access hardware, setting the above guidelines.

AF85-138 TITLE: Signal Processing Chip Family Definition and Characterization

DESCRIPTION: Contemporary signal processors available for digital signal detection, enhancement of signal-to-noise ratio and error-rate reduction, demodulation and decoding, and addressing and routing, are capable of implementation advantages in size and power reduction, and increase in operating speed and sophistication are becoming available in Very High Speed Integrated Circuit and Very Large Scale Integration.

The objective of the procurement is to seek definitions and characterizations of whole families of chips, integrated to provide everything from demodulations to baseband bit streams, including every coding and signal enhancing technique for interference rejection and processing able to provide digital signal throughput at hundreds of megabits per second in the Wide Band Signal environment to be defined by the Defense Communication Agency for the 1990s and post Defense Satellite Communication System (DSCS) era.

AF85-139 TITLE: Switch Matrix Network

DESCRIPTION: Both radio frequency (and intermediate frequency) and baseband multiple input/output switch matrix networks are needed which have good channel tracking, low control power consumption, small time delay, low transmission loss, high directivity and isolation, and high reliability. Present designs and proof of concepts indicate the feasibility of large M x M switch networks. Optimum operating frequencies need to be determined consistent and compatible with the switch matrix design concept. A design effort has to be performed aimed at achieving the above mentioned performance characteristics.

A 25 x 255 port switch matrix network should be designed. Key building blocks have to be developed and tested extensively to demonstrate clearly the realizability of a multiple port switch matrix network.

AF85-140 TITLE: Low Loss Fertile Components for Extremely High Frequency (EHF)

DESCRIPTION: Ferrite components play an important role in communication systems. These components are very rugged and usually lower loss than diode controlled devices. However, at EHF, ferrite components development has not progressed due to a lack of need. The existing components are suited only for laboratory use. Ferrite phaseshifters, isolators and circulators have to be developed which are low-loss, small in size, low in weight, and which use minimum drive power. Temperature stability is also important.

AF85-141 TITLE: Low Power A/D Converter for Space Systems Application

DESCRIPTION: AFSTC seeks analog to digital A/D converter that operates in close vicinity of cooled focal plane at comparable speed for future space systems application. The resulting system should have similar power consumption to current devices. To satisfy the above criteria, the A/D converter should provide 12 bit resolution to 150KHz sample rate, require about 100MW power, and operate between 10°K to 40°K. Other critical features include linearity, gain and off-set stability over lifetime.

AF85-142 TITLE: Development of a Satellite Survivability Methodology

DESCRIPTION: Current military satellites require extensive support from vulnerable fixed ground stations for continued mission performance. The AFSTC seeks to increase space system survivability by automating support functions onboard the satellite (satellite autonomy). In order to implement autonomy in operational satellites, the AFSCT requires a generic methodology that quantifies the effects of increasing levels of autonomy and decreasing levels of ground support versus satellite mission performance and survivability. The methodology can then be used to perform trade-off studies to determine the most effective method of an evolutionary implementation of autonomy for a particular space system. The methodology requires innovative approaches to quantify the complex relationship among autonomy, ground support, mission performance and survivability.

AF85-143 TITLE: Space System Test and Evaluation

DESCRIPTION: It is highly desirable to develop a process to integrate test and evaluation considerations when space systems are in the planning stages. Formerly, test and evaluation has been of secondary importance during planning. This study would examine the feasibility of incorporating test and evaluation procedures into the system planning process. The study would examine all phases during a satellite's lifetime design, production, launch, operational readiness and post operation uses. Emphasis would be on the entire satellite, the individual components and the integration of components into the system.

AF85-144 TITLE: Space Systems Readiness and Support

DESCRIPTION: Improvement in the readiness and support of current and future space systems is of major concern throughout the DOD. In the past, primary emphasis during development has frequently focused on performance and capability. Of secondary importance was the incorporation of new technologies into logistics and support systems. Additional emphasis on readiness and support will improve the reliability, maintainability, and availability that is possible through innovative technology.

A study should be prepared in order to identify ways of developing technology programs that will help meet the Air Force's goals of improved space system readiness and support. The study would examine the current situation, identify possible solutions and make recommendations on a proposed course of action.

AF85-145 TITLE: Turbulence Structuring in High Reynolds Number Flow Fields

DESCRIPTION: Short wavelength laser propagation from an airborne platform is hampered by optical distortion caused by beam scattering as it passes through the aircraft boundary layer and shear layer flows. This scattering is caused by the small scale sizes of the turbulence contained in these regions. There is also evidence of large scale structured turbulence in the flow which is not periodic. Recent work by Dennis Bushnell, et al, of NASA Langley has concentrated on breaking down large scale structures to small scale sizes to reduce skin friction drag. For current purposes, the opposite effect is desired. Innovative approaches are sought to investigate the feasibility of generating or reinforcing large scale, periodic structures in a highly turbulent flow field. By producing suitable periodic structures as the dominant feature of the flow field, the possibility of developing adaptive optics to compensate for them is increased.

AF85-146 TITLE: Dense Plasma Interaction Study

DESCRIPTION: Technologies developed at the Air Force Weapons Laboratory in the areas of high energy density plasmas, plasma implosion physics, and compact high power electrical energy sources, make possible the production of high energy plasma ensembles which may take the form of high speed plasma jets, or high density self confined plasmoids. Starting with a pinched plasma whose number density exceeds atmospheric density by at least an order of magnitude (10 to the 20^{th}/cc) and hose energy density exceeds several mega joules/cc, jets can be formed whose behavior is dictated by fluid (MHD) constraints and whose speed is expected to exceed 100 kilometers/second. Alternatively by introducing appropriate self-contained currents into the ensemble, an internally consistent, self supporting configuration of plasma and magnetic fields (a plasmoid) may be achievable. At this time, the technology of formation of such ensembles is more advanced that is the understanding of the processes which govern the interaction of such ensembles with their environment. Specifically little is known about the interactions of such ensembles with atmospheric and reduced density air, and only slightly more is known about their interaction with solid density materials. The AFWAL seeks innovative approaches to the study and evaluation of such plasma/air and plasma/solid interactions, including theoretical, analytical and computational approaches to the hydrodynamic and MHD aspects of the problem.

AF85-147 TITLE: Gage Development

DESCRIPTION: The Instrumentation Systems Engineering Section of the Civil Engineering Research Division is engaged in making pressure, stress, and acceleration measurements in severe environments. In making these measurements, gage cable survivability is a major concern and cable protection requirements are needed. Such a system should have transducer, memory, power and signal conditioning circuits, and a control device could be either internally or externally triggered. The system must have a data window of 5-100 ms and a sample rate of 10,000 to 500,000 samples per second. The environment of interest would be greater than one KBar and greater than 20,000 g. The system would have control lines for communication with a remote instrumentation van for calibration, T-zero, and other timing signals. Data recovery is intended to be performed by digging up the gages post-test.

AF85-148 TITLE: Quantifying Judgment in Survivability Analyses

DESCRIPTION: AFWL is seeking innovative approaches to the characterization of judgment and technical intuition in the nuclear survivability and vulnerability (S/V) assessment process. Mathematical procedures, such as Fuzzy Set Theory, Ramsey-DeFinetti-Savage Theory, and Bayesian Theory, have possible application in the quantification of subjective elements within current S/V analytic schemes. Techniques developed in the fields of artificial intelligence and image processing may be adapted to the problem area, which represents the nuclear blast and shock response of protective structural facilities.

AF85-149 TITLE: Spatial, Spectral, Time Resolution of X-Ray Bursts

DESCRIPTION: The AFWL is seeking innovative approaches to develop spatially, spectrally, and temporally resolved detection of x-ray bursts. Detection devices should be less than 0.5 meters in maximum dimension and less than 15 kilograms in weight. The spectral range of interest is 50 eV to 5 KeV. The flux range of interest if 10 to the ninth to 10 to the thirteenth watts isotropic at detection distances of 1 to 3 meters (i.e., 10 to the third to 10 to the seventh watts/cm squared). The spectral resolutions of interest are 0.1% to 10%. The time resolutions of interest are 0.5 to 6 nanoseconds. There is special interest in time resolved, space resolved crystal and grazing incidence spectrographs.

AF85-150 TITLE: Solid State Power Switching Devices

DESCRIPTION: Solid state power switching devices which can reliably switch electrical currents ranging from 5 milliamperes to 10 amperes are needed for control of special weapons. The devices must also provide minimum circuit isolation in the non-operate (OFF) mode of at least 75K ohms. Volume occupied by the devices must be less than comparable electromechanical relays.

AF85-151 TITLE: Laser Window Materials and Designs

DESCRIPTION: High energy laser window materials and design concepts are needed which will allow the transmission of large amounts of laser power with negligible optical distortion. High quality windows are needed for lasers operating at wavelengths of 3600-4200 nm, 1315 nm, and 300-600 nm. Transmission of 99.9 percent is desired. Materials and concepts must be scalable to sizes which allow transmission of megawatts of power with less than 0.05 waves RMS of optical distortion, across the full aperture, at the design wavelength.

AF85-152 TITLE: Spatial and Time Resolved Electron Beam Profile Measurements

DESCRIPTION: The AFWL is seeking innovative approaches to nonperturbative measurements of relativistic electron beam profiles. The resolutions of interest are submillimeter to centimeter and subnanosecond to microsecond. What is desired is a means to measure electron density profile in an electron beam/atmosphere

interaction for pressures ranging from 10 to the negative third atm to 1 atm. Beam parameters are 10 to 100 kiloamps, 1 to 30 MeV, and 0.5 to 2 cm radius.

AF85-153 TITLE: Condition of Airport Runways

DESCRIPTION: AFWL is seeking innovative approaches to improving the survivability of the US bomber force and C3I aircraft by providing the aircraft with a means of monitoring the condition of civilian airports which may have been under nuclear attack. The monitors must be nuclear survivable and be capable of transmitting information on the usability of the runways to approaching aircraft. Inexpensive techniques are required for sensing runway condition, nuclear and weather environments, and for automatically providing the data to a secure transponder. The monitoring system should also provide to the airport operators continuing information on runway, environmental and weather related safety conditions during normal operations.

AF85-154 TITLE: Space Shuttle Outgassing

DESCRIPTION: Study the production of positively charged ions (of all relevant species) by outgassing, and determine the contribution which they make to the charged particle distribution surrounding the space shuttle orbiter.

The desired product of this research is a report containing a bibliography and review of previous work in this area, formulation of the problems in a mathematical and computational framework, with preliminary results.

AF85-155 TITLE: Picture Generation by the DMSP Spaceborne Microwave Radiometer

DESCRIPTION: The Defense Meteorological Satellite Program (DMSP) will be flying a four channel dual polarization microwave radiometer (SSM/I). The SSM/I is designed to estimate atmospheric and geophysical parameters by a numerical inversion technique. A more physical approach would be to generate a series of images from the seven channels (one channel has single polarization). It is possible to generate computer images from the SSM/I data, but since the SSM/I was not designed as an imager, the images may not be true representations because of alising. In order to obtain quality images, the antenna transfer function has to be determined. The objective of this research is to investigate the SSM/I antenna transfer function to determine if high resolution pictures can be generated. If so, how could other spectral bands be combined with the microwave pictures to determine atmospheric and surface characteristics.

AF85-156 TITLE: RAMAN Detection for Balloonborne Lidar

DESCRIPTION: A balloonborne lidar system is currently in fabrication and is scheduled to being flight operations in 1984. Balloon flights will be made during nighttime hours at an altitude of about 35 km (115,000 ft.) over desert cerrain. The lidar has a neodymium:YAG transmitter with simultaneous outputs at 1064, 532 and 355 nm at power levels of about 200,140, and 35 millijoules, respectively (2 milliradian divergence). The receiver is a 50 cm Cassegrain telescope with a 4 milliradian field-of-view.

To investigate the feasibility of adding to the present system one or more detectors to observe Raman scattered radiation, in addition to the Rayleigh/Mie, as a technique for determining the concentrations of both major and minor constituents of the atmosphere, e.g., N2, 02, H20, in the region below the balloon using the basic lidar system described above. Considerations of altitude resolution, integration time and signal-to-noise factors will be addressed in an error analysis appropriate to the use of Raman detection. For the most promising spectral region revealed by this analysis, a Raman detection. For the most promising spectral region revealed by this analysis, a Raman detection system will be designed which is compatible with the present lidar.

AF85-157 TITLE: Space Correlations of Total Cloud Cover

DESCRIPTION: Using surface observations from about 50 sites selected worldwide, find horizontal correlation functions of total cloud cover. The observations are given in eighths of cloud cover and the periods of record range from ten to fifteen years. The stations will be grouped into three distinct climatological regions – arctic, mid-latitude, and tropical. Both the product moment and tetrachoric correlations will be calculated for all station pairs in each region for each of the midseason months (January, April, July and October). The correlation values will then be plotted as a function of distance between stations. The plots will be grouped by midseason months and by region for each of the two correlations (product moment and tetrachoric). This will result in 24 plots (4 midseason months x 3 regions x 2 correlations). The resulting correlation functions will be found by analyzing these plots using appropriate nonlinear regression techniques. This will be a 6 month effort culminating in a scientific report.

AF85-158 TITLE: High-Current Density Electron Gun for Space Flight

DESCRIPTION: The objective is to design and construct a flight module that will ultimately lead to the construction of an electron gun suitable for rocket, space shuttle and satellite flight. Active experiments are being planned to determine if electron beams can be used to control or mitigate the effects of hazardous or turbulent space environments on Air Force system operations. To maximize testing possibilities for effective controlled use of electron beams, an electron gun with a wide dynamic range in current, energy and current density is needed. The gun should be capable of delivering currents from 100 milliamperes to Amperes with energies to tens of kilovolts. A cathode design must be developed that is capable of meeting these specifications and a module must be designed and constructed that meets the requirements for space flight. The module must be tested and delivered with a report summarizing the module capabilities and including projections on the performance of the complete electron gun.

AF85-159 TITLE: Intersatellite Image Comparisons

DESCRIPTION: Meteorological satellites differ from each other in the way image data are obtained. They differ in type of scan, wavelength sensitivity, footprint size and spacing, and response; and it becomes difficult to make quantitative intercomparisons. This effort has the objective to find out directly from image samples ways to circumvent these problems in order to interpret satellite cloud images correctly. By “directly” is meant the actual comparison of data and the development of schemes to make one source of data comparable, for operational systems, to another. In terms of the footprint and possibly the wavelength band, LANDSAT could be made to look like one of the meteorological satellites, but not vice versa. Wavelengths of prime interest are the visible and the far infrared. Physical calibrations and factors contributing to differences should be studied. The goal is to develop ways to make data from one satellite comparable to another for purposes of correctly interpreting the data from various systems. Initially, the investigation should use observations which are near the subpoint of the satellite in order to avoid the complicating factors of interpreting data at large scan angles. The satellite observations of major interest are from GOES, the Air Force DMSP, NOAA polar orbiting satellites, and from LANDSAT. Data comparisons desired are GOES to DMSP, NOAA to DMSP, LANDSAT to DMSP, and LANDSAT to GOES.

AF85-160 TITLE: Carbon-Carbon (C-C) Material Property Sensitivity

DESCRIPTION: Service failures of solid rocket nozzle components demonstrate their performance is sensitive to material property variations that have not been adequately characterized. As the density of a 2-D carbon-carbon exit cone increases, the strength and stiffness increase, but in an undetermined proportion. When the stiffness increases, thermal stresses usually increase and this rise in stress could exceed strength improvements. The net effect in this case would be to increase the risk of failure. Critical elevated temperature compression properties are also sensitive to processing and designers must know all first order property sensitivities and their impact on thermostructural behavior in order to set acceptance criteria for fabrication.

The objective of this program will be to identify critical material properties for the thermostructural behavior of solid rocket nozzles in a service environment; to characterize experimentally the sensitivity of these properties to process and raw material variations about a baseline material system now in use; to develop process-property

relationships in graphic form and show historical data; to prepare engineering design guides for nozzle designers and composite fabricators for structural carbon-carbon materials.

AF85-161 TITLE: Rocket Nozzle Computer Code Sensitivity Analysis

DESCRIPTION: Three computer programs are being used at AFRPL for liquid rocket nozzle analysis. These include: The Solid Performance Program (SPP), the Two Dimensional Kinetics Program (TDK), and the Boundary Layer Integral Matrix Procedure (BLIMP). Three in-house projects will experimentally measure nozzle performance of several engines using N2H4, MMH, or H2/O2 as propellants, in order to validate the predictive capabilities of these programs. An analysis shall be performed to determine the sensitivity of vacuum specific impulse (Isp) prediction to variation of input parameters, and to allow selection of boundary layer parameters to be measured experimentally to validate the computer codes.

AF85-162 TITLE: Carbon-Carbon Exit Cone Billet Engineering Design

DESCRIPTION: The design of carbon-carbon exit cone billets for solid rocket nozzles for even the most common constructions, materials and process cycles continues to be the source of serious hardware problems. Progress is being made in isolating and solving raw material problems, in-process material response problems and facility dependent problems.

The objective of this program will be to provide for the design process of the advanced modeling tools developed for material architecture, for material response and for predicting the processing environment. A second objective, and one which must occur in parallel with the first, is to assemble the available in process material characterization data and make it available to the billet designer in a form readily usable by the new modeling tools.

The modeling tools to be developed include the following:

Display billet, net part, ply pattern, and interleaf geometries; Output data for fabrication lay-up and perform tooling; Output material rotation angles throughout the billet, and net-part for computer structural analysis; Quantity fabric distribution: Permit design or redesign based on architectural constraints; And generate billet or net-part geometries given the ply pattern.

AF85-163 TITLE: Particle Infrared (IR) Optical Property Measurement Technique Definition and Design

DESCRIPTION: Accurate prediction of missile IR signatures with state of the art computer codes (e.g., the JANNAF SIRRM Code) is limited by – and highly sensitive to – uncertainties in IR optical properties. An accurate quantification of these will significantly improve plume radiation predictions since accurate data is not available, and some species, most notable Al2O3, are susceptible to large property changes under the contaminated conditions of rocket plumes.

The objective is to define techniques and procedures to be used to determine the particle index of refraction and emissivity. The measurement system design and total parameter estimation error budget shall be generated, and the impact of particle density and shape on the measurement error of the designed system shall be included. The design shall be capable of determining the complex index of refraction and emissivity of particulates at a minimum of eight temperature steps, with the steps at or near 300K, 500K, 1000K, 2000K, melting temperature plus 100K and 2500K. The design shall also be capable of determining the optical parameters at a minimum of five spectral regions at or near 0.3-, 0.6-, 1.2-, 3-, and 10-microns. Any other specification suggestions will be welcome.

The design will be such that captured, purposefully contaminated or pure form Al2o3, ZrO2, C, ZrC, and MgO particles in the submicron and several micron size ranges can have their IR optical properties determined. Finally, an important driving constraint in the measurement technique definition is that the chemical composition and particle morphology must remain unchanged; any alteration of these could significantly change the properties of the already contaminated particles.

AF85-164 TITLE: Composite Material Bond Agent Investigation

DESCRIPTION: Recent investigations in solid rocket nozzle development has discovered a lack of property data concerning structural adhesives. This data is required for the design and analysis of nozzle components. This study would create a baseline characterization of the most commonly used bonding agents and adhesives in solid rocket nozzles. The critical analysis and design properties of resins, epoxys, and polyamides should be addressed. The characterization would need to be accomplished at both room temperature and elevated temperatures simulating a motor firing. Various properties, such as the amount of bonding achieved, the effects of fillers and cure methods, property degradation, strengths, strain, creep, conductivity, char yield, and thermal expansion would be investigated and related to their temperature dependency.

AF85-165 TITLE: Particle Contamination Technique Definition and Design

DESCRIPTION: Accurate prediction of missile IR signatures with state of the art computer codes (e.g., the JANNAF SIRRM code) is limited by – and highly sensitive to – uncertainties in IR optical properties to much greater accuracy than the order of magnitude discrepancy that may exist with current data. The present error may arise because some species, most notably Al2O3, are susceptible to large property changes under the contaminated conditions of rocket plumes.

The objective is to define techniques and procedures to contaminate commercially pure samples of Al2O3, ZrO2, C, ZrC, and MgO particles in the submicron and several micron size ranges to resemble particles captured from rocket exhaust plumes. The particle contamination system design must be capable of matching rocket exhaust particles to base material, contaminant and surface morphology at temperatures ranging from 100K to 2500K and at least five spectral regions at or near 0.3-, 0.6-, 1.2-, 3-, and 10-microns. The total error budget for the particle contamination system design will also be generated. Any system design must not introduce changes to the chemical composition or particle morphology to either rocket exhaust or artificially contaminated particles.

AF85-166 TITLE: Phase Shifters for Phased Arrays

DESCRIPTION: Ferrite phase shifters are a major factor in the development and acquisition of phased array radars. They are lossy and expensive; sources of supply are very limited. Other alternatives may either lack the power-handling capability of ferrite phase shifters or suffer greater losses. Alternatives to current 4-bit and 6-bit ferrite phase shifters with respect to performance (insertion loss and peak power handling capacity) and cost (phase shifter and driver) are sought.

AF85-167 TITLE: Routing Algortihms for Networks Comprising of Heterogeneous Link Capacities

DESCRIPTION: Packet networks deployed in a tactical environment will have to contend with individual links that provide many different transmission rates or capacities. These can range from 2.4 kb's to as high as MB's as an example. Current routing techniques do not directly consider individual link capacities in the route selection although they can have considerable effect on the system throughput. The key to good throughput is to be able to determine the best routing strategy in a situation where the overall traffic and the varying link capacities all impact on a selected route. The purpose of the proposed effort will be to develop and document specific routing algorithms.

AF85-168 TITLE: Improved Microwave Signal Control Components for Phased Array Antennas

DESCRIPTION: Wideband phased arrays for military applications require non dispersive time delay units and phase shifters which operate efficiently in the microwave frequency bands. Variable time delays up to 30 nanoseconds are required with a resolution on the order of 1 per carrier frequency of the radar. Instantaneous bandwidths of 10 percent of the carrier frequency are necessary in devices with significantly less loss than found in current acoustic and switched line devices. Phase shifters with resolution equivalent to eight bits are required to carry up to 50 watts of peak power with insertion losses less than 1 dB. It is desirable that these devices be in a form which permits

integration into monolithic microwave circuitry as the cost and losses of current production devices make them unsuitable for many array applications. Research into new approaches to achieving these devices is encouraged.

AF85-169 TITLE: Multi-Wavelength Narrow Band Sources

DESCRIPTION: To increase utilization of fiber optic communication links it is desirable to multiplex signals, with the greatest advantage gained by using multiple wavelengths. Minimum attenuation and dispersion occurs in the neighborhood of 1300 nm and thus multiple sources are needed in this wavelength range. Several efforts utilize a variety of dispersive mechanisms (e.g., the using grating dispersion.) This approach requires a separate stable and pre-determined wavelength source for each channel. At present these sources are injection laser diodes which are expensive, fragile and require external temperature stabilization.

We are seeking methods to generate multiple narrow band signals, separated by approximately 15 nm from a smaller number of sources. One approach could be use of a variable wavelength source to generate several wavelengths for external modulation. A recent effort in this area has been the development by Bell Laboratories of the cleaved coupled cavity laser which has shown up to 10 different lines spaced 10 angstroms apart, which can be pulsed rapidly from one line to another. Another method to be considered is the optical equivalent of mixing to generate multiple wavelengths. This could be accomplished in theory by the use of a non-linear medium to generate multiple wavelengths from the interaction of two independent light sources. Other approaches should be examined.

The resultant wavelength spectra would then be externally modulated by independent signals to generate the wavelength division multiplexed output.

AF85-170 TITLE: Active Modulator Compensation Techniques

DESCRIPTION: Signal fidelity requirements in high performance tactical and strategic surveillance systems put stringent voltage specifications on the final amplifier power supply. Previously, modulator/power supply pushing factors were minimized via the construction of “stiffer” power supplies. The size/weight constraints of “state-of-the-art” systems precludes such an approach. Alternative methods of maintaining amplifier signal fidelity in the ground and airborne environment must be developed which will minimize size and weight maintaining performance commensurate with 50 to 60 db MTI cancellation ratios and high reliability and maintainability.

AF85-171 TITLE: Compositions for Radiation Hard Doped Core Optical Fibers

DESCRIPTION: Optical fibers are being incorporated into the designs of many new C3I weapons systems designs because of their EMP/EMI immunity and other advantageous properties. All presently available optical fibers that can meet mechanical and thermal systems requirements have silica-based compositions. Except for systems utilizing less than a few hundred meters of fiber, graded-index optical fibers must be used to meet bandwidth requirements. The graded-index is achieved by doping the fibers’ silica cores with index modifying elements. All of these fibers show significant permanent and transient increases in loss of transmission when exposed to nuclear radiation and consequently are not compatible with many systems nuclear vulnerability requirements. A program for the development of new, or modifications of present, compositions for doped-silica core optical fibers that will be more radiation resistant is, therefore, needed. Optical fibers fabricated on the basis of possible improved core compositions should be provided for tests of their radiation vulnerability.

AF85-172 TITLE: Submicrosecond Fiber Optic Switches

DESCRIPTION: Modern fiber optic communications networks require electro-optical switching components for optical signal routing. Local area networks in particular require a series of 2 x 2 optical bypass switches to maintain network continuity if a local terminal fails. Generally, the usefulness of optical switching components, including electro mechanical switches are deficient in speed. The millisecond response times have limited the applications areas of those devices. Research is needed to demonstrate the feasibility of new classes of fiber optical switches.

Ferroelectric liquid crystals offer the promise of an improvement in switching speed by more than three orders of magnitude, with an on/off cycle requiring less than one microsecond in principle. Bistable switching is also possible in theory. Bistability represents another improvement because no power is required to sustain either state.

If feasibility can be shown, the results will apply also to waveguide switching in integrated-optics applications.

AF85-173 TITLE: Intelligent Noise Stripping for Speech Enhancement

DESCRIPTION: Existing noise stripping algorithms for voice communications channels do not take advantage of knowledge of the communications vocabulary for speech enhancement. In many communications environments, limited vocabularies are the rule rather than the exception. Such information can be used in a machine "expert" fashion to apply interference rules regarding the intended message. Application of such knowledge source can be used to improve the intelligibility and information content of the message following the noise stripping process. This effort will provide an analysis and a suggested design for an expert system approach to using lexical and syntactical knowledge and inferences to improve speech enhancement algorithms.

AF85-174 TITLE: Modulated High-Current Electron Gun

DESCRIPTION: Recent advances in the development of electron guns suggest that it may be feasible to exploit their use in the ionosphere for the generation of ELF/VLF/LF radiowaves. Such use requires the development of a gun capable of producing high current (tens of amperes) which is rugged, of light weight and small enough to be suitable for operation on a rocket or space shuttle. The gun should produce electrons with variable energies extending into the kilovolt range and be capable of being modulated from 0 to at least 100kHz. The cathode configuration is most crucial to the development of an electron gun suitable for use in space. The power supply required for the cathode operation will largely decide the size and weight of the gun module and is dependent upon the efficiency of the cathode. The objective of this research is to develop a cathode which minimizes the heating power required per ampere of beam current, is of sturdy construction to withstand rocket flight, does not deteriorate during exposure to atmospheric gases while cold and produces at least tens of amperes current with electron energies up to at least tens of amperes current with electron energies up to at least tens of kilovolts while being capable of modulation from 0 to at least 100 kHz.

AF85-175 TITLE: Radio Electronic Combat Vulnerability Analysis (RVAN)

DESCRIPTION: Conduct analysis of selected developmental system designs to identify weaknesses which are potentially exploitable by an enemy. The analysis should consider the impact of existing and projected radio electronic combat threats on system performance in an operational environment. It should also identify the characteristics of future capabilities which would allow an enemy to exploit the system.

AF85-176 TITLE: Direction Finding (DF) Cut-to-Cut Correlation

DESCRIPTION: A key task required for several command, control and communications (C3) countermeasures is emitter location by direction finding (DF) and triangulation. To have the requisite location accuracy, the base line has to be relatively long and several direction observations (cuts) may be required. For many signals a number of emitters will probably be operating on the same frequency and the duration of any particular emission will be relatively short. Thus, if a single DF platform is used, it will be necessary to correlate an emission received at one time with later emissions. If multiple platforms are used, one has to correlate emissions between them.

Specific emitter identification and fingerprinting are two of the terms applied to the capability to tag a particular emitter so that its emissions can be correlated. The term fingerprinting will be used in the widest sense as any emitter tag that can be used for correlation. Areas of interest for a given set of signals are: 1. Which ones can be fingerprinted by existing systems? 2. What is the signal-to-noise ratio? 3. What is the dwell time? 4. What other

reception requirements are important? 5. What are the associated error probabilities as a function of the signal environment? 6. Are the techniques applicable in a wartime environment? 7. What are performance expectations? 8. Are there promising approaches that are being neglected? This task would develop and document fingerprinting and identification techniques that resolve the above issues, in particular for cut-to-cut correlation.

AF85-177 TITLE: Remote Communications Antennas

DESCRIPTION: Investigate feasibility of providing remote antenna and/or transmitter subsystem capability for critical ground communications thermals, e.g., for JTIDS or GMF satellite terminals, as an anti-ARM or anti-location protection measure for the main terminal and operating personnel. Select a candidate system and determine the modifications (signal format, etc.) necessary to accommodate remoting.

AF85-178 TITLE: Adaptive Beam Communication Antennas

DESCRIPTION: Investigate the feasibility and desirability of using self aligning beam array antennas for communications to reduce the probability of intercept outside the main beam and improve jam resistance by increasing the effective radiated power. Determine appropriate array configuration as a function of frequency from VHF through millimeter waves. Determine appropriate codes for synchronization beam forming signal. Such a system could eliminate the acquisition delay associated with narrow beam systems. This technique is differentiated from numerous jammer nulling phased array system, although a nulling subsystem could be combined with the beam forming subsystem.

AF85-179 TITLE: Cover, Concealment, and Deception (CC&D) Penetration

DESCRIPTION: Many enemy targets, especially command, control, and communications (C3) targets, will make maximum use of cover, concealment and deception (CC&D). Additionally, most weapon systems require imagery evidence of a target before they are tasked. Synthetic aperture radar (SAR) systems provide an attractive source of such imagery, since they can operate from standoff positions and are relatively unaffected by weather. The capability of SAR to find enemy C3 targets under various conditions of CC&D should be analyzed. In addition to an assessment of SAR performance against obscured (or partially obscured) targets, the analysis should address the added value of using a prior knowledge, change detection schemes, and/or higher resolution.

AF85-180 TITLE: Forward Air Controller (FAC) Jammer Study

DESCRIPTION: The communications between an enemy Forward Air Controller (FAC) and the aircraft it controls is a lucrative target for jamming. An analysis is needed to determine the type of jamming system that would be most effective against the FAC communications while remaining the least vulnerable to enemy counteractions, issues of mobility versus vulnerability; airborne versus ground based options; operational concepts; jammer command, control and communications (C3); and required coordination with friendly forces should be explored.

AF85-181 TITLE: Use of Surface Acoustic Wave Devices for Electronic Countermeasures Analysis

DESCRIPTION: Surface acoustic wave (SAW) technology has produced small, highly reliable devices which may be used to detect the presence of ECM, chaff, and ground clutter in received radar signals. This technique may have broad application to threat simulators on electronic warfare test and training ranges. First, the research should review existing threat simulator hardware and determine if the device may be practically adapted to both emitter/receivers and emitter-only type systems. Second, the research should review the SAW device capability to isolate chaff, noise jamming, and deceptive ECM techniques from the received signal. Third, the research should propose hardware and software approaches to process and quantify the detected chaff and ECM.

The report of this research will be used as a basis for enhancing existing training range capabilities and could have far reaching application in reducing the cost of future training range threat simulators.

AF85-182 TITLE: Generalized Nonnuclear Munitions and Armaments Research

DESCRIPTION: New and improved ideas/concepts and analysis methodologies are desired in the area of nonnuclear munitions and armaments. These include chemical and fuel-air explosives, energy sources and conversions, bombs, submunitions, warheads, fuzes, dispensers, guns, rockets, ammunition, ammunition feed systems, mines, sensors and seekers, explosives, propellants, carriage and release equipment, aerodynamic and structural technologies, tactical missile guidance and control techniques, and chemical warfare technology. Some examples of desired research are low drag/observable weapon airframes, conformal ejector racks, integrated fuzing, millimeter wave seekers/sensors for midcourse and terminal guidance, heavy metal self-forging fragments, heavy metal shaped charges, long rod penetrators, reactive fragment warhead, and computational fluid dynamica.

AF85-183 TITLE: Gallium Arsenide Solid State Accelerometer (GASSA)

DESCRIPTION: Acceleration/deceleration is always present during the launch and/or terminal engagement of air-launched weapons. Various devices, mainly mechanical, have been utilized to provide inputs to safe and arm subsystems and fuzing logic for safe separation and/or detonation decisions. Due to the low sensitivity and poor accuracy of existing economical devices these fuzing decisions have of necessity been gross, limiting effectiveness parameters such as launch envelope and warhead detonation point. Previous development programs on the silicon solid state accelerometers have demonstrated the technology necessary to batch fabricate single chip accelerometers in the range from .01g to 100,000g with sensitivity versus natural frequency equal to or better than commercially available discretely fabricated accelerometers in the $100 to $300 price range. Although considerable progress has been made, the desired level of accelerometer sensitivity has not been achieved. Recent advancements in the use of gallium arsenide devices suggest that this technology has the potential of a sensitivity factor improvement of 5 to 20 over that of silicon.

The objective of this program will be to investigate the potential of gallium arsenide accelerometers to improve sensitivity levels. This program will concentrate on improvement in areas to include: temperature stability, yield, packaging for environmental survivability, reliability, and ease of interfacing with decision logic circuit. One of the main efforts will involve placement of all temperature compensation and amplifier circuitry on the accelerometer die instead of on a separate substrate as in the earlier development program.

AF85-184 TITLE: Development of an Energetic Polymer/Plasticizer for Plastic Bonded Explosives

DESCRIPTION: Currently, plastic bonded explosive formulations utilize an inert binder system which comprises 15-20% by weight of the system. This inert material contributes no energy to the system and dilutes (separates the crystals) the explosive system resulting in uneven energy being imparted to special warheads, such as shaped charge and long stand-off penetrator items, where smooth detonation front and high energy are critical for performance.

These systems could possess several merits: reduce the amount of costly and critical HMX required; enable the substitution of RDX for HMX (resulting in increased energy), increase the performance in special warhead technology, and improve safety characteristics.

The necessary effort could be a study to assess the feasibility of producing energetic polymer/plasticizers and to do formulations. If analyses and tests show the approach has promise, then a series of loaded test hardware should be tested to select the best candidates to continue work toward greater performance and improved processing.

AF85-185 TITLE: Development of High Voltage Transformers for Electronic Fuzes

DESCRIPTION: Electronic bomb fuzes are under development which employ high energy electrical firing circuits to initiate the explosive train as opposed to conventional detonators. These high energy circuits require small, high efficiency, high reliability transformers to convert supply voltages of 20-30 volts to 2-2.5 kilovolts for storage on capacitors. In order to maintain the highest level of safety, it is necessary to completely isolate the high voltage circuits or restrict the generation of high voltage to a unique set of environmental circumstances. To this end the transformer must possess inherent in its design or through dedicated circuitry the ability to function as a "decision-making" device and a fail safe high energy barrier.

This effort could be divided into two phases. Phase I would investigate several approaches to the problem and result in a number of candidate designs. Phase I would not be restricted to a particular type of transformer or a particular technique though the following should be included: 1. Approaches to tuning the transformer to the alternating current output of an environmental power supply. 2. Approaches to generating the high voltages across a continuous metal barrier, conceived as a can which contains all the high voltage circuits. 3. Unconventional transformers such as piezoelectric transformers and others should be addressed along with conventional devices.

Phase II would entail the fabrication of a small number of examples of the most promising design(s) for evaluation and possible integration with prototype fuzes.

AF85-186 TITLE: X-Ray Smear Camera

DESCRIPTION: Optical smear camera utilize a slit and rotating mirror to sample events propagating in one direction in space as a function of time. Optics limits one to surface observation of detonation phenomena for opaque explosives whereas an x-ray system given sufficient energy resolution and dosage would permit interior study of detonation phenomena. An analytic study to determine the feasibility and to develop a preliminary design for an x-ray smear camera is needed as the first phase.

AF85-187 TITLE: Development of External Aid for Rapid Transfer/Alignment

DESCRIPTION: One of the problems with inertially guided tactical weapons is that of rapid transfer/alignment. Vector matching between the master (aircraft) and slave (missile) inertial system typically requires up to five minutes to achieve an accurate transfer/alignment. During this time the aicraft must perform several maneuvers in order to excite the proper state variable so that discrepancies may be observed. A major contributor to the complexity of this problem is the fact that the slave system is on the aircraft's wing and therefore, undergoes motion due to the wing's dynamic flexure.

An approach which needs to be investigated is the development of an external aid which could provide an almost instantaneous transfer/alignment (e.g., an optical scope). Such an aid would be hard fixed to the aircraft fuselage and would have the capability to observe the attitude (and possibly the time-rate of change of attitude) on the store. This observation could then be fed into a one step Kalman filter. Innovative ideas are sought and various technologies should be considered.

The necessary effort could be divided into two phases. Phase I would be a study to assess the feasibility of the approach, preferably with a covariance analysis. If Phase I shows the approach has promise, then Phase II would involve testing the unit to confirm its level of performance.

AF85-188 TITLE: Barrel Materials for Electromagnetic Rail Guns

DESCRIPTION: Electromagnetic rail guns are being developed to fire projectiles of several grams at velocities of several kilometers per second. The barrels of these rail guns are composed of two narrow conducting rails extending the full length of the barrel and separated by insulating rails to form the bore. Currents on the order of a million

amperes flow down one conducting rail, through an armature at the rear of the projectiles, and back through the other conducting rail to the source. The armature may be either a solid conductor or a plasma.

Research and development is needed to find a candidate material for both the conducting and insulating rails. Several rail guns have been constructed that use copper alloys for conducting rails and fiberglass composites for insulating rails. Neither material is satisfactory because the barrel environment erodes the rails. Heat and pressure cause surface melting and ablation of the materials. The damage mechanisms should be defined (i.e., friction, ohmic heating, hot gas cutting) and material characteristics established to resist these mechanisms. These material characteristics must include the conductivity required by the conducting rails, and the resistivity required by the insulating rails. Using the material characteristics, candidate materials for both conducting and insulating rails can be proposed. These materials might be metals, alloys, ceramics, composites, or advanced formulations.

AF85-189 TITLE: Digital Mission Management System for Advanced Dispenser Weapons

DESCRIPTION: The next generation of submunition dispensing weapons will be very sophisticated. They will be blended-body, conformally carried configurations that will be powered with pulsed motors, and require for some targets both midcourse and terminal guidance. Additionally, the advent of smart submunitions will require the capability to precisely coordinate target sensing and submunition dispense events. Sequential dispensing from multiple submunition bays will be required for some target and submunition combinations. Further, since some targets (e.g., airfield runways and armor columns) require a dispensing vehicle to geometrically match its submunition-dispensing pattern with that of a specific real time target orientation, a highly capable digital mission management system is required for next generation advanced dispenser vehicles. The objective of Phase I of this program would be to define a system architecture for a digital mission management system for an advanced dispenser weapon, which would have the following capabilities as a minimum:

a. Be compatible with a MIL-STD-1760 aircraft stores management system.
b. Perform initialization functions for guidance systems (midcourse and terminal).
c. Perform propulsion management (energy management) functions.
d. Perform submunition fuze setting functions.
e. Coordinate submunition (or subpack) ejection events with target sensing data.

Phase I would also produce a detailed program plan for follow on Phase II work. Phase II of the program would involve fabricating a bread board simulation of the digital mission management system and conducting system verification tests.

AF85-190 TITLE: Development of Inertial Navigation Unit for Tactical Weapons

DESCRIPTION: Inertial navigation is an attractive alternative to tactical weapon guidance because it is completely autonomous and cannot be jammed. The problem with the use of inertial guidance is high cost associated with sufficiently accurate systems. One approach which should be investigated is the use of newly developed low cost inertial instruments (gyros and accelerometers) in a gimbaled platform system. In a gimbaled platform the low cost instruments would be subject to a more benign environment would increase sensor accuracy and reduce computational requirements but increase mechanical complexity. A systems approach is necessary to determine the cost effective approach.
The necessary effort could be divided into two phases. Phase one would be a study to assess the feasibility of this approach. If phase one shows the approach has promise, then phase two would be the construction of a unit which would be tested to determine the level of performance which could be achieved.

AF85-191 TITLE: Investigate Fluid Flow Phenomena to Improve the Performance of Flight Vehicles

DESCRIPTION: This project supports research in external aerodynamics, turbulent and unsteady flows, and internal fluid dynamics. The objective is to investigate the fluid flow phenomena that strongly influence the aerodynamic performance and efficiency of current and future flight vehicles, to understand the structure of turbulence in shear flows, and to improve our understanding of and capability to predict three-dimensional flow past geometrically

complicated configurations. We are interested in methods for automatically generating solution adaptive computational grids; exploiting the unsteady flow characteristics that will improve aerodynamic efficiency and enhance performance; improving experimental and theoretical modeling capability for deflected engine exhaust jets that may interact with solid surface and encounter cross flows; numerically simulating time-evolving turbulence features; passively, actively, and interactively controlling turbulence characteristics; numerically computing on and off design flows in low aspect ratio and high pressure ratio compressor blade passages. Proposals should be in one or more of the following areas: Effects of viscosity, turbulence, pressure and temperature gradients, compressibility, and non steadiness of flows; interactions of the shock wave turbulent boundary layer for a range of Mach numbers; severe separation from wings and wing and body configurations; turbulent structures and their interactions in free and bounded shear layers; the behavior of attached and separated unsteady shear layers affected by time dependent boundary conditions; generic characteristics of driven, unsteady separated flows; flows in internal passages in lasers; compression system instability; dynamic stall on two and three dimensional lifting surfaces; aerodynamically forced response of stator blades; and effective active cooling for turbine blades.

AF85-192 TITLE: Improve the Long Term Durability and Reliability of Aerospace Structural Systems

DESCRIPTION: This project supports research in structural mechanics, structural durability, and civil engineering. The objective is to explore the behavior of aerospace structural systems in a variety of environments, the long-term durability and reliability of those structures, and the properties and behavior of new materials to be used for strategic and tactical structures. We are interested in developing structural response models, models for predicting damage growth and structural life, and constitutive models for geotechnical and construction materials; studying the strength and fracture characteristics of brittle materials; investigating explosion-induced soil liquefaction; and developing, identifying, and measuring in situ soil properties. Proposals should be in one or more of the following areas: The role of internal and external nonlinearities of structures; ways in which to control the behavior of the structures; interactions between flexible aerospace systems and their on-board controllers; ways in which fatigue and fracture damage structures, especially componsite structures; new materials or approaches that will lead to the survivability of strategic structures in a nuclear weapons environment, the survivability of strategic and tactical structures in a conventional weapons environment, and rapid repair of tactical and logistical aircraft launch and recovery surfaces.

AF85-193 TITLE: Enhance the Performance of Flight Vehicles by Improving Air Breathing and Rocket Combustion and Plasma Energetics

DESCRIPTION: This project supports research in air breathing combustion, diagnostics in reacting media, rocket combustion dynamics, and plasma energetics. The objective is to study the physical and chemical processes of combustion in an air breathing propulsion system; develop techniques for sensing temperatures, concentrations, and velocities in energy conversion systems; understand combustion and reacting flow processes; and study advanced space propulsion. We are interested in models of turbulent fluid transport processes, photochemical and catalytic methods for more stable ignition and enhanced combustion of present fuels and future alternatives, noninvasive sensing and diagnostic techniques and strategies, methods for analyzing the stress of nonlinear viscoelastic materials, thermal protection techniques for measuring plasmas. Proposals should be in one or more of the following areas: Fluid transport processes; stable ignition and enhanced combustion of present and future fuels, control of the rate of combustion, and reduction of undesirable combustion products; the combustion of liquid fuel and high energy slurry fuels; reacting flows in the hostile environments of high performance systems; combustion products in plumes; thermodynamic, kinetic, and transport properties of pure substances used for propellants; sources of physical (nonchemical) energy, such as electrically conductive flowing gases or plasmas; the mechanism of release of that energy; and the devices for converting that energy; the phenomena of energy coupling and transfer of energy flows in electrode and electrode less concepts under plasma dynamic pulsed and steady state equilibrium and nonequilibrium flowing plasma; characteristics of electrical and hydrodynamic flows; instabilities of plasma bulk and wall layers; interactions of plasma surface, electrode, magnetic, and electric fields; energy losses to inert parts; plasmas generated at high magnetic fields and pressures; and characteristics of advanced refractory materials exposed to working fluids and life-limiting mechanisms.

AF85-194 TITLE: Innovative Research to Understand the Physical Processes of the Atmosphere

DESCRIPTION: We are seeking proposals for basic research in the following areas: Mesocale dynamics, including the use of ST-type radar; planetary boundary layer coupling to the mean flow, size and composition of atmospheric aerosol; aircraft icing; lightning; electromagnetic signal propagation (visible, infrared, millimeter wave, etc.); ionospheric-thermospheric coupling; and ionospheric processes that affect communications and surveillance systems.

AF85-195 TITLE: Develop New and Improved Analytical Instrumentation and Advanced Concepts in Structural Polymers and Ceramics

DESCRIPTION: This topic includes five principal subareas: chemical techniques, structural chemistry, surface chemistry, molecular dynamics, and chemical reactivity and synthesis. Research in chemical techniques focuses on developing new and improved analytical instrumentation and methods in electrochemistry and detection (specifically the nature of electrodes and electrochemical reactions). Research in structural chemistry encompasses programs in polymer science, glass, and advanced structural ceramics and ceramic composites. Research in surface chemistry investigates gas and solid surface interactions, surface characterization, surface reaction kinetics and mechanisms, the characterization of thin films, the interaction and reactivity of gases with thin films, the stability of substrate and thin film interfaces, film nucleation and growth, and interactions of intense light and thin films. Research in molecular dynamics examines well defined microscopic molecular systems in reactive and nonreactive molecular collisions by using selected energy states of reactants and analyzing the energy collisions by using selected energy states of reactants and analyzing the energy through available molecular energy levels or through emission of radiation. Research in chemical reactivity and synthesis seeks to explore new and better methods for characterizing and synthesizing new organic, inorganic, organometallic, and organometalloid compounds (particularly organosilicon and fluorocarbon substances), and novel approaches for making reaction intermediates that can be used to tailor chemical structures with desirable properties.

AF85-196 TITLE: Improvement in the Technology of Monolithic Microwave and Millimeter Wave Integrated Circuits

DESCRIPTION: This project includes 3 topics: monolithic microwave and millimeter wave integrated circuits, super conducting analog signal processing, and process modeling for compound semiconductor technology. The research in monolithic microwave and millimeter wave integrated circuits seeks to identify improvements in materials, processing techniques that can be automated, and device designs. Monolithic refers to the fabrication on a single semiconductor chip of active and passive components, such as transitors, capacitors, inductors, and interconnections. Needed research includes work on substrates, active layers, device modeling, millimeter wave device designs, and monolithic integration. Implementation will be in gallium arsenide or indium phosphide or related ternary compounds at frequencies up to 100 GHz.

One promising approach for future signal processing applications is the use of circuits based on super conducting analog elements. The basic functional needs for high speed, wide bandwidth signal processing are delay (compact structure), tapping (accurate), multiplication (dynamic range), and summation (phase coherence). Candidate research topics include more reproducible and uniform tunnel oxides; discrete devices, such as convolvers and correlators; more complex circuitry, such as programmable matched filters and time-integrating correlators; a combination of superconducting and cooled-semiconductor devices; and photo-introduction of signals into the cryostat to avoid wires.
Silicon device and integrated circuit technologies have been greatly fostered by the availability of computer simulation tools, such as SUPROM and SPICE. Under the topic of process modeling for compound semiconductor technology, we are seeking suitable process models for compound semiconductor materials, such as gallium arsenide and indium phosphide. We are interested in research that proposes models for bulk materials processing, such as liquid encapsulated Czochralski (LEC) and horizontal or vertical Bridgeman. Other areas of interest include device and/or integrated circuit models that incorporate the standard fabrication steps, including implantation, thermal annealing, dielectric formation, metalization, etc.

AF85-197 TITLE: Development of Novel Thin Film Deposition Techniques

DESCRIPTION: This project includes research in novel thin film deposition techniques. Currently, Air Force optical systems are limited in performance by thin film properties. Existing deposition techniques, such as thermal evaporation and sputtering, result in films with a microstructure described by the structure zone model. Thin film performance could be improved with deposition techniques, such as energetically enhanced chemical vapor deposition, molecular beam epitaxy, ionized cluster beam deposition, or other ultra high vacuum epitaxial techniques, that permit more control over film morphologies. The ultimate goal of investigating these techniques is to find a technique for the deposition of a perfectly amorphous or a perfectly single crystal optical film that has thin film properties approaching those of the bulk material. We are interested in research that proposes to characterize novel deposition techniques or to model growth and deposition phenomena.

AF85-198 TITLE: Research in Neuroscience, Psychophysiology, and Toxicology

DESCRIPTION: This project includes research in bioreactivity, bioenvironmental hazards, biocybernetics and workload, and information processing. Physiological characteristics determine how well people work in demanding environments. Human machine systems that are not well matched to human physiological characteristics cannot operate optimally. In an effort to explain the links between physiological characteristics and human performance, the research in bioreactivity examines the mechanisms that control neuronal activity. The current focus is on neuronal regulation and adaptation, including control of neurotransmitter release and postsynaptic response, activation of second messengers and ion channels, and influence of neurohormones. We are interested in studies that relate events at the different levels of organization which are involved in regulating the state of responsiveness of the intact organism.

Air Force operations may result in the release of physical and chemical agents that may be harmful to Air Force personnel and the environment. The objective of research in bioenvironmental hazards is to obtain data on the biological effects of exposure to electromagnetic radiations from pulsed and continuous wave sources and to clarify how Air Force relevant chemicals produce their toxic effects.

Research in biocybernetics and workload is oriented toward studying the stages of information processing and allocation of attention during work. Emphasis is on noninvasive techniques for monitoring neural activity during performance of sensory, cognitive, and motor tasks.

Information processing covers research on the adaptive networks in biological systems and machine systems and the human sensory-motor processes. The goals are to explain the neuronal mechanisms that underlie goal-directed behavior, pattern recognition, learning, and associative memory; to stimulate new approaches to the design of adaptive networks for intelligent machines; and to quantitatively describe those aspects of sensory-motor processing that are most relevant to aircrew performance, selection, and training; to rapid and accurate interpretation of computer-generated information; and to the development of robotic systems.

AF85-199 TITLE: Research in Mathematics of Control and Dynamics for Aerospace Systems

DESCRIPTION: Basic research in mathematics covers the mathematics of dynamics and control, computer science, computational mathematics, physical mathematics, probability and statistics, and system science. Research in the mathematics of dynamics and control include robust control, adaptive control, stability theory, optimal control stochastic control, filtering, nonlinear control, and identification and optimization of lumped and distributed parameter systems. Research computer science focuses on distributed and parallel processing, programming theory, artificial intelligence, and data management systems. Research computational mathematics seeks to develop algorithms that can be coded reliably, efficiently, robustly, or automatically for serial, vector, and equations and algebraic equations. Research in physical mathematics examines new analytical models and methods for solving physical and applied mathematical problems in aerodynamics, aeroelasticity, and electromagnetic theory. Research in probability and statistics addresses new methods and the expansion and generalization of existing methods in probability theory, statistics, stochastic processes, statistical communications theory, and reliability for real systems.

Research in system science includes optimal filtering, signal processing, information theory, applied analysis, finite mathematics, optimization, and graph theory in network analysis.

AF85-200 TITLE: Research on Physical Processes of Plasmas, Lasers, Microwave Devices, Space Primer Power, and Directed Energy Concepts

DESCRIPTION: This project supports research in optical physics, pulsed power, atomic and molecular physics, particle beam technology, and the physics of collective phenomena. Optical physics addresses research in the vacuum ultra light to the near millimeter range of the spectrum. Emphasis is on coherent light and its interactions with matter. Pulsed power investigations center on electron beam, laser triggered, and sustained switching, the spectroscopy of switch plasmas, an understanding of high power repetitive opening switches, and an understanding of the ways switch electrodes and insulators break down and erode. Research in atomic and molecular physics concerns the properties and interactions of atoms and molecules. Research in particle beam physics includes investigations of intense, high energy, charged and neutral beams and studies of negative ion sources. Studies of the physics of collective phenomena examine the collective effects of low temperatures and the physical processes associated with producing radiation at X-ray, soft X-ray, millimeter wave, and microwave frequencies.

AF85-201 TITLE: Study Near-Earth Space Conditions to Prevent Degradation of Military Systems Operating in Space

DESCRIPTION: Space environmental conditions produced by radiator and atomic particles can endanger the mission and degrade the performance of military spacecraft, disrupt the detection and tracking missiles and satellites, distort communications, and interfere with surveillance operations. The objective of research in this project is to study the particles, electric and magnetic fields, and radiation that affect the environment of near-earth space. Studies should be designed to examine the following topics: Ways to specify and forecast solar wind and magnetospheric conditions with ground-based measurements, such as radio star scintillations and geomagnetic pulsations; celestial background radiation; ways to improve the resolution of space object images; distribution of plasma and magnetic fields within the magnetosphere; and the earth's radiation belts and their responses to natural and artificial disturbances.

AF85-202 TITLE: Improve the Accuracy of Locating Geographical Positions and Establish Methods to Reliably Differentiate Between Earthquakes and Underground Detonations

DESCRIPTION: The research in this project is stimulated by the need to guide and control missile systems, conduct advanced tests of components, site silos, discriminate among the sources of nuclear explosions, and conduct reconnaissance and surveillance missions. The scientific disciplines involved are geodesy, gravity, geology, and seismology. Research in geodesy defines the exact position of targets with respect to missile launch sites. Research in gravity examines the effect of gravity on missile guidance systems along flight paths. Research in seismology studies the effects of earthquakes, nuclear explosions, and other natural or system-generated noise on the degradation of missile guidance systems before launch.

AF85-203 TITLE: Advanced Physiological Measures to Predict Performance Decrement

DESCRIPTION: There is increasing need to develop extremely sensitive predictors of impending decrements in operational performance before they would have an opportunity to impact a mission. While some behavioral measure of performance would do this, few of these are non-intrusive, or are easily implemented in real world settings. Yet, as systems become more complex and less forgiving, and as they depend more on cognitive abilities, the need for early warning and prediction becomes critical. Physiological metrics such as the cortical evoked promise of providing the desired non intrusive, sensitive metrics. The realization of these possibilities, however, will require considerable innovative work in terms of hardware design and miniaturization, as well as, artifact rejection and other significant advances in data analysis software. In addition, validity, reliability, and field acceptance of such procedures must be defined. For any creative solution to these problems, initial efforts to define

the feasibility and specific implementation plan are required. This effort should not be limited to the above mentioned techniques, but should consider any physiological procedure which satisfies the criteria of potential validity, field usability, and predictive sensitivity.

AF85-204 TITLE: Human Factors Engineering (HFE) Performance Measurement, Test and Evaluation

DESCRIPTION: Information is sought concerning techniques and methodologies of testing and evaluating the total HFE design of major weapon systems, and command, control, and communications centers. Although the adequacy of specific hardware may be evaluated in a reasonably straightforward manner by reference to applicable human engineering design standards, the adequacy of the man-machine combination in the total systems context is a more difficult determination. Meaningful performance test/evaluation criteria and requirements must be established well before the formal test and evaluation stage of system acquisition. Novel approaches are sought in predicting, observing, quantifying and relating human performance in the operational environment to total mission and system effectiveness. Research is needed to develop techniques or methodologies that can assist in answering these questions: 1. Will the new equipment and software actually improve operator performance under specific conditions; and 2. If the capability is targeted at improving one function within an operational situation, what will be the impacts on associated functions with the operation? Products may include measures of effectiveness that planners and developers can use to evaluate alternative concepts before decisions are made to build the capability into hardware and software.

AF85-205 TITLE: Expert System Tools for Job Aiding

DESCRIPTION: With the move away from intermediate maintenance and austere basing concepts, the "remove and replace" philosophy will place an intolerable burden on the logistics pipeline. Consequently, flexible new tools for job aiding must be developed for allowing more efficient maintenance. Expert systems technology offers one solution for solving this problem. Software tools that emulate the capabilities of a senior technician for completing complex maintenance tasks are needed, and exploratory development is necessary in knowledge representation, troubleshooting techniques, and expert system software.

AF85-206 TITLE: Display for Low Level Terrain Following Flight

DESCRIPTION: This project consists of improving the display format(s) used by aircrews when performing terrain following (TF) flight. No systematic engineering approach has been utilized to test candidate display formats. Human factors considerations were not adequately assessed in development of the TF display formats currently in use, thus the formats do not effectively present the required information to insure mission demanded (200-500 feet above ground) pilot performance when flying manual TF. Purpose of this project is to take such factors as aircraft performance, available avionics processing capability, current display technology, and human information processing and tracking capability into consideration; then test out candidate format designs.

AF85-207 TITLE: Development of Radiofrequency Radiation Detection Systems

DESCRIPTION: The U.S. Air Force operates many radiofrequency radiation (RFR) emitters. Thus, a relatively large work force (about 100,000) is exposed to some level of RFR on a daily basis. Hand held radiation monitors are available to measure RFR levels from about 0.1 – 100 mW/cm squared, but there are no devices available that can measure personnel exposures at lower RFR intensities over any reasonable time period.
Some form of integrating personnel dosimeter is desired for quantifying RFR exposures in the Air Force workplaces. Both a wearable device and a device that could be fixed at a regular work station (such as avionics repair and maintenance shops) are needed. It is desirable that it be able to measure periodic exposures to RFR levels from 0.001 to 1 mW/cm squared.

AF85-208 TITLE: Development of Hand Held Integrating Dosimeter

DESCRIPTION: Develop a prototype (hand held) electronically integrating radiation dosimeter using solid state detectors capable of detecting electrons (betas), protons, alpha particles, X and gamma rays. System should have digital readout in millirad from 00001 to 99,999 millirad. System should be capable of accurate operation in fields from 5 mrad/day to 100 rad/hr. System must be rugged enough for use in STS and aircraft. Special Modification – Solid State Detector System for detection of fast neutron radiation fields.

Applications – 1. On board radiation monitor for space craft, 2. Fall out radiation monitoring, 3. Monitoring of albedo neutron radiation in LEO missions and high altitude aircraft flights, 4. Radiation monitoring in power reactor environments.

AF85-209 TITLE: Improved Neck for Ejection System Testing Manikins

DESCRIPTION: The neck structures of ejection system and crash/impact test manikins have limited human like biofidelity in their response to vertically and horizontally applied accelerations. Increasing interest in the effects of stresses in and transmitted through the neck due to the encumbering of the head with various life support, protective and performance enhancing equipment has resulted in a requirement for the development of an improved mechanical neck structure. This structure must provide proper human like, three dimensional kinematics of the head for horizontally and vertically applied accelerations; possess provisions for readily modifying internal resistance to flexation; have integrated, multiaxis force transducers for measurement of transmitted forces; and be designed to be compatible with current state of the art testing manikins. Initial emphasis is on design concepts, methods of mechanical implementation and demonstration of the feasibility of the approach. The program is expected to lead to prototype fabrication; testing for response and compliance with overall testing manikin requirements; and a final refined design suitable for multiproduction purposes.

AF85-210 TITLE: Heating Rate Effects on Thermal and Mechanical Properties of Phenolics

DESCRIPTION: Phenolic materials are used in solid rocket motor nozzles as insulators. Thermal stresses, therefore, arise due to expansion of these materials. Research is needed to better understand the relationship between rate of heating and thermal/mechanical properties of carbon and silica phenolics. Of particular concern is the effect of heating rate on the cross ply coefficient of thermal expansion.

The objective of this project is to define and verify test techniques which will yield reliable values for thermal and mechanical properties of phenolics under various heating rates. The ultimate goal would be to develop a data base for phenolics under various heating rates and temperatures.

AF85-211 TITLE: Internal Inspection of Long Tubes

DESCRIPTION: The 1000 ft. track of Range G must be inspected prior to each firing to insure that there is no damage to the track surface, and that no foreign objects protrude into the model path. At the present, this task is accomplished manually, which requires approximately four hours to complete. It is desired to develop a device that would accomplish this task and reduce the time required. The device must locate and remove foreign objects. The track has a 7-inch outside diameter with four rails protruding inwards to provide a 2.5-inch inside diameter tube 500 ft. in length.

AF85-212 TITLE: Continuous Wave Radar for Range Track G

DESCRIPTION: It is desired to fabricate and evaluate a phase coherent, bistatic, dual receiver, continuous wave (cw) superheterodyne radar system for use in the Range Track G. The radar should operate at a transmission frequency of 70 GHz. Solid-state, frequency stabilized microwave sources and associated phase-locking techniques

should be investigated in attempting to fabricate a state-of-the-art cw radar capable of sensitivity of the order of 90dbm.

AF85-213 TITLE: Determination of Installed Thermocouple Response

DESCRIPTION: Turbine engine test requirements include numerous temperature measurements of the facility and engine. Most of these temperature measurements are made using conventional thermocouples (T/C's) installed in direct contact with the test specimen and are not readily accessible. A technique is needed to determine the frequency response of these installations. A potential technique (Seebeck Effect) involves using small electrical currents to heat or cool the T/V junction and observing the return to ambient rates. Requirements of such a technique include: 1. compatible with T/C types IC, CA, and CC 2. operate with T/C lead resistances up to 40 ohms, 3. accommodate thermocouple wire sized from No. 36 to No. 18, and 4. use non lethal voltages.

AF85-214 TITLE: Combustor Exist Temperature Measurement

DESCRIPTION: The current generation of gas turbine engines operate at combustor exit gas temperature levels higher than the reliable operating range of existing gas temperature measurement systems used for engine development testing. As a result, combustor exit gas temperature is generally calculated based on work balance or combustion efficiency assumption. Accurate measurement of combustor exit gas temperature in conjunction with other measurements would allow a more reliable determination of both combustion and turbine efficiency. A gas temperature measurement system capable of reliable operations in an engine/test cell environment covering the range of approximately 2,000°F to 3,200°F with a measurement uncertainty of ±15°F is needed.

AF85-215 TITLE: Automatic Clearance Control Labyrinth Seal

DESCRIPTION: Measurement of aircraft propulsion engine thrusts during operation at altitude flight conditions normally requires use of a pressure balanced labyrinth type seal to isolate the engine from the test cell ground plane. The engine mounting system, thermal growth, and other installation characteristics can require more than otherwise desirable seal radial clearance. A reliable method of sensing seal radial clearance and remotely adjusting the lab seal system to provide automatic seal-to-duct clearance control is needed. Radial positioning of the lab seal to within ±0.01 of the desired setting is required.

AF85-216 TITLE: Robotics for Rapid Runway Repair (RRR)

DESCRIPTION: Repairs to airfield pavements following a non-nuclear attack must be made rapidly and under extremely hazardous conditions. Numerous bomblets capable of throwing hundreds of lethal fragments several hundred feet as well as other types of unexploded ordnance will probably be scattered throughout the area. They may be in the craters themselves, in scabs in the pavement, or mixed with the debris surrounding the craters. Others may be in the grass adjacent to the pavement. The bomblets may include both antipersonnel and antivehicle types with various fuzing mechanisms including simple time delay and antidisturbance fuses. While an attempt will be made to clear these bomblets prior to starting pavement repairs, many will remain. Personnel and equipment casualties are likely, especially during the initial phases of the repairs. One approach to reducing the personnel casualties is to perform the initial repair tasks with unmanned equipment. Research should identify the most promising robotic equipment as well as the best concept for operations (remotely controlled with appropriate feedback systems, computer controlled with preprogrammed tasks, or some combination).

Research should also identify pertinent trade-offs, such as: survivability, time to perform the repair tasks, cost, flexibility, etc.

AF85-217 TITLE: Modeling of Reinforced Concrete Using the Discrete Element Method (DEM)

DESCRIPTION: A requirement exists to develop an analytical model to predict spall and cracking of the reinforced concrete subjected to conventional weapons effects. Current models use the Finite Element Method (FEM), which allows deformations, but not break up of the structure. The Discrete Element Method (DEM) allows the structure to separate and split into individual elements acting as rigid bodies which is more realistic in a high dynamic loading environment. The DEM technique offers a technological opportunity to accurately model reinforced concrete spall and cracking behavior subjected to high dynamic loading and strain rates. The effort will include state of the art assessment of applicable analytical models and supporting mathematical techniques, developing the DEM analytical model, and experimentation to validate the DEM technique and fully develop the DEM as an analysis tool.

AF85-218 TITLE: Feasibility of Modeling Fire Suppression

DESCRIPTION: A requirement exists to devise a technique for scaling the required quantities of fire suppressants from small aircraft to large aircraft fires. The required quantities of specific suppression agents can only be determined for large three dimensional aircraft fires by costly testing. Cost effective experiments can be done on small fires but the means to translate small-scale results to large-scale performance does not exist. This is because of the lack of practically correct and readily application techniques to scale fire behavior.